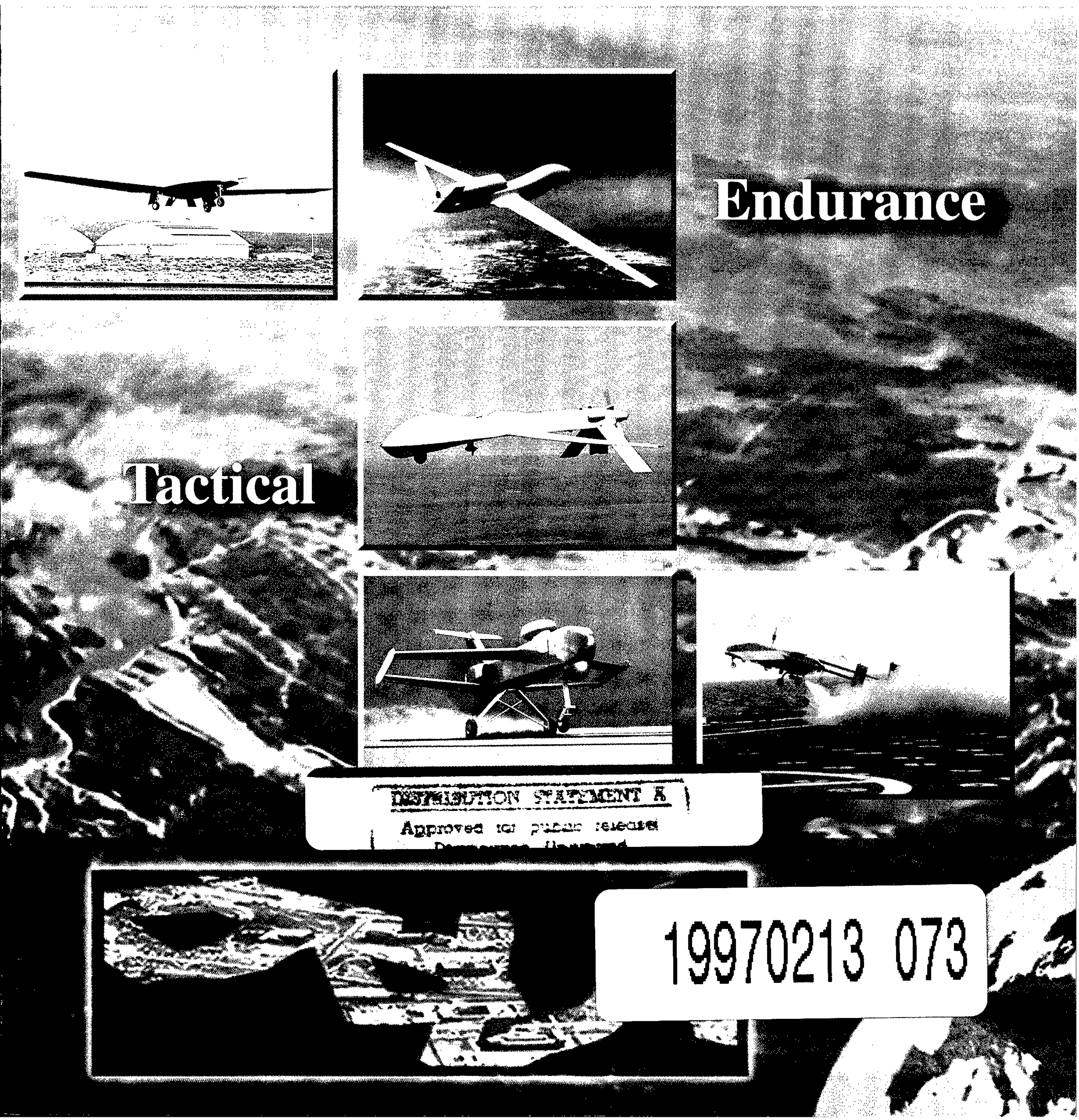
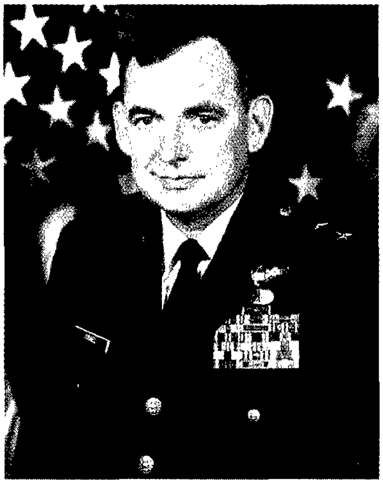
UAV Annual Report FY 1996

6 November 1996

DEFENSE AIRBORNE RECONNAISSANCE OFFICE





OUR SECOND UNMANNED AERIAL VEHICLE (UAV) ANNUAL REPORT provides an overview of the Defense Department's UAV program activities for fiscal year (FY) 1996. The Defense Airborne Reconnaissance Office (DARO) is chartered to manage the Defense Airborne Reconnaissance Program (DARP), which includes both tactical and endurance UAVs among its component program elements.

DURING THE PAST YEAR, UAVs have seen major programmatic changes, have continued to demonstrate unique capabilities, and have experienced increasing acceptance by operational users. This report highlights their recent achievements, describes their acquisition plans and issues, and projects the DARO's UAV vision for the future. Key accomplishments, together with a DoD-wide perspective, are summarized below.

I've seen the cities of men and understand their thoughts.

Homer, c. 900 B.C.

As indicated by Homer's insightful statement, THE CONCEPT OF INFORMATION DOMINANCE *has a long history. What is so vastly different today is that technological capability, system performance and operational infrastructure support have converged to allow us to exploit new opportunities in ways never before imagined. For years warfighters have articulated the needs for* situational awareness, target identification, dominant battlefield awareness, dominant battlespace knowledge, *and* information superiority. *Now we have the ability to move from words to deeds.*

The DARO's first responsibility is to develop and maintain the DoD's integrated airborne reconnaissance architecture as a framework for the development and acquisition of improved airborne reconnaissance capabilities. Today, we have an abundance of exciting and important collection, processing, exploitation and dissemination opportunities and the problem is to make choices among them and integrate them into the architectural structure. For our manned platforms, we have a game plan to selectively improve sensors. For our UAVs, we are now ushering in new capabilities in both platforms and sensors to constitute our family of tactical and endurance UAVs. As our architecture migration pictorial shows (page 3), we are concentrating on the best "mix" of manned and unmanned systems to meet warfighting needs well into the next century.

Last year we published our first UAV Annual Report. This is our second edition, and its purpose is to provide updates from 1995 and highlight the significant accomplishments that UAVs have achieved this past year, FY 1996. Simply stated, UAVs are moving from words to deeds. They are being recognized in out-year "vision" documents as providing both a cost-effective solution to our goal of extended reconnaissance and bases for other high-value military and civil applications. There are many Services and agencies involved in the rapid improvements and fielding of UAVs, and on their behalf we are pleased to publish this second edition.

OVER THE PAST TWELVE MONTHS, our expanding UAV community has tackled new doctrinal, operational concept, requirements and interoperability issues. It was a year of "firsts" on many fronts and each achievement is the product of a great deal of dedicated effort and DoD-contractor teamwork.

a. <u>Analysis and Architecture</u>*. The overarching efforts that went into refining our integrated airborne reconnaissance strategy as well as laying the groundwork for a joint, interoperable mix of UAVs*

The video mosaics on the covers were provided by the National Information Display Laboratory (NIDL).

in an architectural framework deserve much praise. We need to continually improve the analytic base on which decisions are made. The analysis must reach to an assessment of the contribution of intelligence systems to military outcomes in scenarios that are judged to be consequential. Several efforts to quantify the airborne reconnaissance force mix, such as the Reconnaissance Study Group, Joint Warfare Capability Assessments, the SIGINT Mix Study, the C4ISR[1] *Mission Assessment, DARO analysis, the National Reconnaissance Office imagery mix study and others, have proven most helpful. Thus, we see our reconnaissance architecture as embedded in a larger information system roadmap. The value of any architecture is in helping to shape investment decisions for the future, and we have started this process.*

b. Acquisition Initiatives. Integrating acquisition reform initiatives into our UAV programs has helped lead the way for other DoD Advanced Concept Technology Demonstration (ACTD) programs. For example, the Predator *ACTD was the first successful ACTD to transition to a production program and its experiences will be applied to other DoD efforts. Four of our five active UAV programs are (or were) ACTDs —* Outrider, Predator, DarkStar, *and* Global Hawk; Pioneer *is a fielded system — and are progressing well. In addition, integrated product teams (IPTs) are helping to develop requirements and concepts of operations (CONOPS) for the Tactical Control System (TCS), a new development to assure interoperability between our UAVs and their intelligence products for joint operational users. IPTs have also helped to determine tactical synthetic aperture radar (SAR) and data link options. Another key area of IPT support is identification of commercial processes, products and services to support our open architecture.*

c. Funding Support and Program Prioritization. The Congress has been very supportive of the Department's UAV programs and, for the third year in a row, has added funds to our UAV efforts. In addition, the Joint Requirements Oversight Council (JROC) prioritized UAV programs and provided stability in the joint requirements process that supports warfighter needs. The new JROC Review Board (JRB) has also helped us by framing UAV issues, evaluating operations, and proposing recommendations for JROC consideration. The number one priority for UAVs remains the tactical UAVs (Outrider *and* Pioneer), *with* Predator *and the High Altitude Endurance (HAE) UAVs as numbers two and three, respectively.*

d. Achievements. During the last year, we have accomplished the following UAV program-specific actions:

- *On 2 May 1996, the Tactical UAV, or* Outrider, *ACTD contract was awarded for a 24-month period of performance. First flight will occur six months after contract award and a low-rate initial production (LRIP) option for six systems may be exercised before the ACTD ends, i.e., late in FY 1998. The current requirement is for 62 systems (at four air vehicles [AVs] per system), plus attrition spares.*
- Predator *has been the most operationally active UAV program this year. During FY 1996,* Predators *have flown more than 530 missions for nearly 2,500 flight hours — 159 missions and 1,169 flight hours supporting Bosnia operations alone.* Predator *flew the first UAV SAR and Ku-band satellite link mission this year. Dissemination of imagery via the quickly constructed Joint Broadcast System provided a long-sought-for "common picture of the battlefield" to multiple receiving sites both in-theater and back in the U.S. It also operated under control of, and sent information to, a submerged submarine during one demonstration exercise, and supported a carrier battle group during another.* Predator's *marinization feasibility study has been completed and its report will be available in early FY 1997. The JROC identified near-term configuration upgrades that include UHF voice radio, IFF, and wing de-icing. The SecDef approved system and program management agreements for its follow-on acquisition and operational support. The current operational requirement is for 16 systems (at four AVs per system), plus attrition spares.*

1 *Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance.*

- Pioneer *also deployed to Bosnia and supported the 1st Armored Division; additional* Pioneers *support fleet operations offshore. The Congress provided funding to improve both engine performance and the avionics.* Pioneer *has experienced an unusual rate of mishaps this year, but the improvements cited will help the situation. Thus,* Pioneer *has helped us gain experience to improve reliability for all UAVs. We are planning to extend its operational life from FY 2000 to 2003, when* Outrider *is expected to be available in quantity. The revised requirement is for nine systems through FY 1999 (at five AVs per system), with a gradual phase-out.*

- DarkStar *experienced both its first flight and its first mishap within 24 days of each other. The first successful fully autonomous UAV flight with a low-observable design took place in March 1996. The mishap took place in April and resulted in a year's delay and an approximately $22 million impact to the program. To correct the problem, three configuration design changes are being considered: "hiking" the nose gear, moving the main gear, and sweeping the wings. The next flight is planned for May 1997.* DarkStar's *eventual force size is being determined.*

- Global Hawk *is proceeding well. The wing and body were mated without a problem. Static and integration tests are on schedule. First flight is scheduled for 1997. This will be the first UAV to use a common processor for both electro-optical/infrared (EO/IR) and SAR imagery.* Global Hawk's *eventual force size is being determined.*

- *The TCS development is now underway. The JROC fully supports a common, modular and scalable ground station for tactical UAVs. The TCS will be compliant with the Joint Technical Architecture (JTA), Airborne Reconnaissance Information Technical Architecture and the Joint Interoperability Interfaces, thereby assuring UAV and product interoperability and utility among multiple operational users.*

- *Finally,* Hunter *has enjoyed considerable success during the past several months. Although the DoD decided to cease production after the LRIP buy of seven systems,* Hunter *has performed flawlessly on several exercises and demonstrations to refine UAV employment concepts, and, like* Pioneer, *continues to be used for payload development.*

FROM A DoD-WIDE PERSPECTIVE, Joint Vision (JV) 2010, *published in July 1996, represents the vision of the Chairman, Joint Chiefs of Staff (CJCS), for joint warfighting in the 21st century. Its C4I "building codes" are contained in the JTA. Our Integrated Airborne Reconnaissance Strategy and its implementing Airborne Reconnaissance Information Technical Architecture remain in full agreement with JV 2010's provisions for the employment of information to support its key operational concepts —* dominant maneuver, precision engagement, full-dimension protection, *and* focused logistics. *We are continuing to study how UAVs can support joint warfighting concepts as the Defense Department prepares for the Quadrennial Review of Roles and Missions during FY 1997.*

Finally, in the post-Cold War era we can expect our forces to be deployed for a variety of purposes in many parts of the world. The rule, rather than the exception, will be deployment with coalition partners, notably NATO members. We will need to be interoperable — not only with our own forces but also with NATO forces and those of our coalition partners.

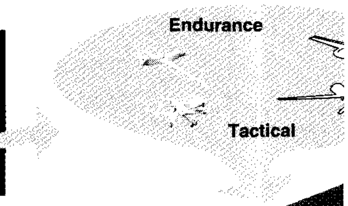
All in all this has been a good year for UAVs and we expect an even better year, next year. Thank you for your continued support.

MajGen Kenneth R. Israel, USAF
Director, Defense Airborne Reconnaissance Office

Supporting the Warfighter

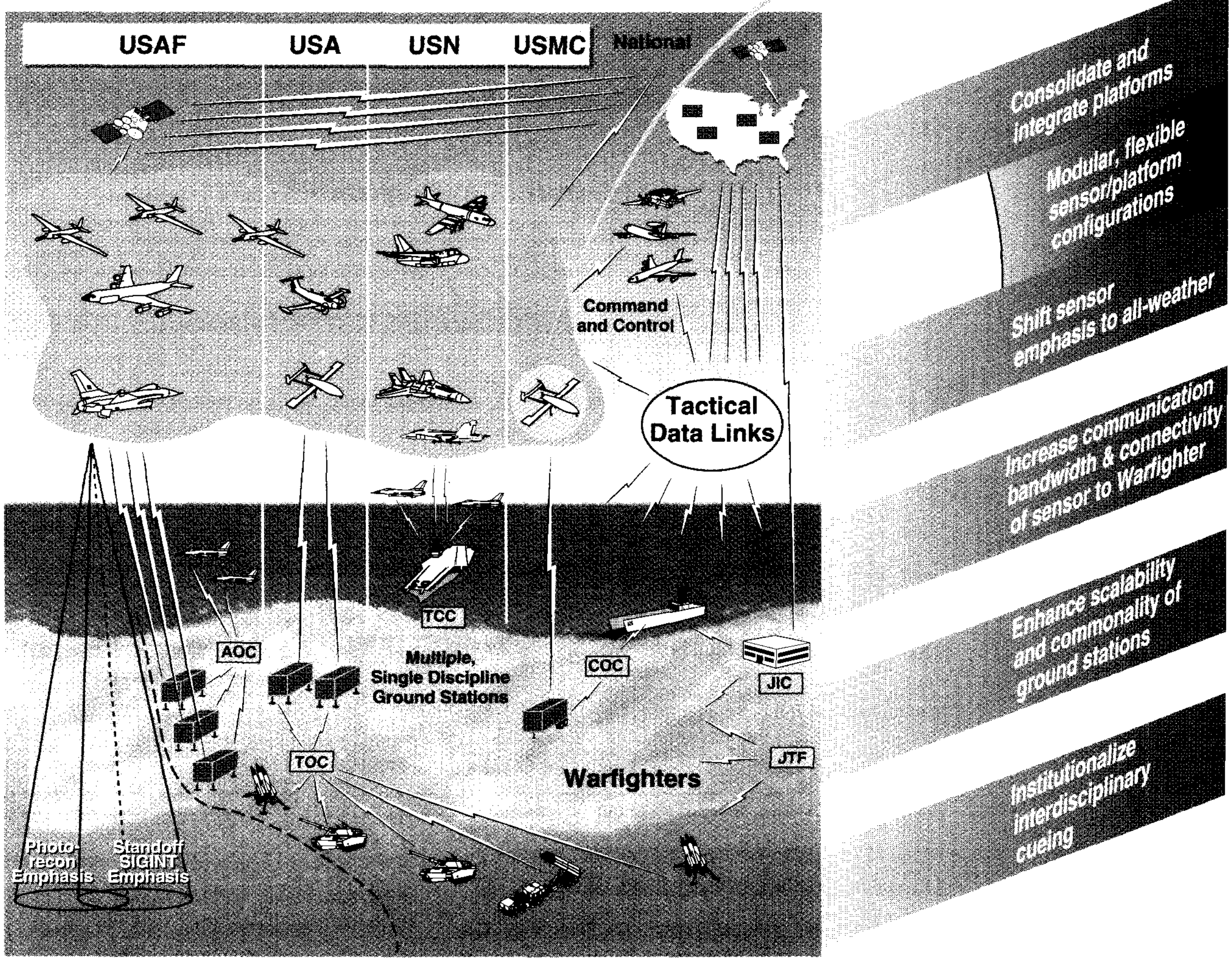
PRESENT

ARCHITECTURE MIGRATI



Capable systems for single-service intelligence disciplines, but —

- ***Limited flexibility, air/ground reconfigurability, and interoperability***
- ***Lack of Joint integration across disciplines, support for the warfighter***
- ***Complicated operations, maintenance, and logistics support***



Ongoing Improvements :

- ***Continuous broad area coverage***
- ***Higher-resolution data to support precision strikes***
- ***Improved sensors for BDA***
- ***Improved OTH communications and connectivity***
- ***Increased communication bandwidth***
- ***Better information retrieval and distributi***
- ***Comprehensive source correlation***
- ***Synchronization with warfighter needs***

ACS Advanced Common Sensor AOC Air Operations Center ATR Automatic Target Recognition C4I Command, Cc
JTF Joint Task Force MASINT Measurements and Signatures Intelligence SAR Synthetic Aperture Ra

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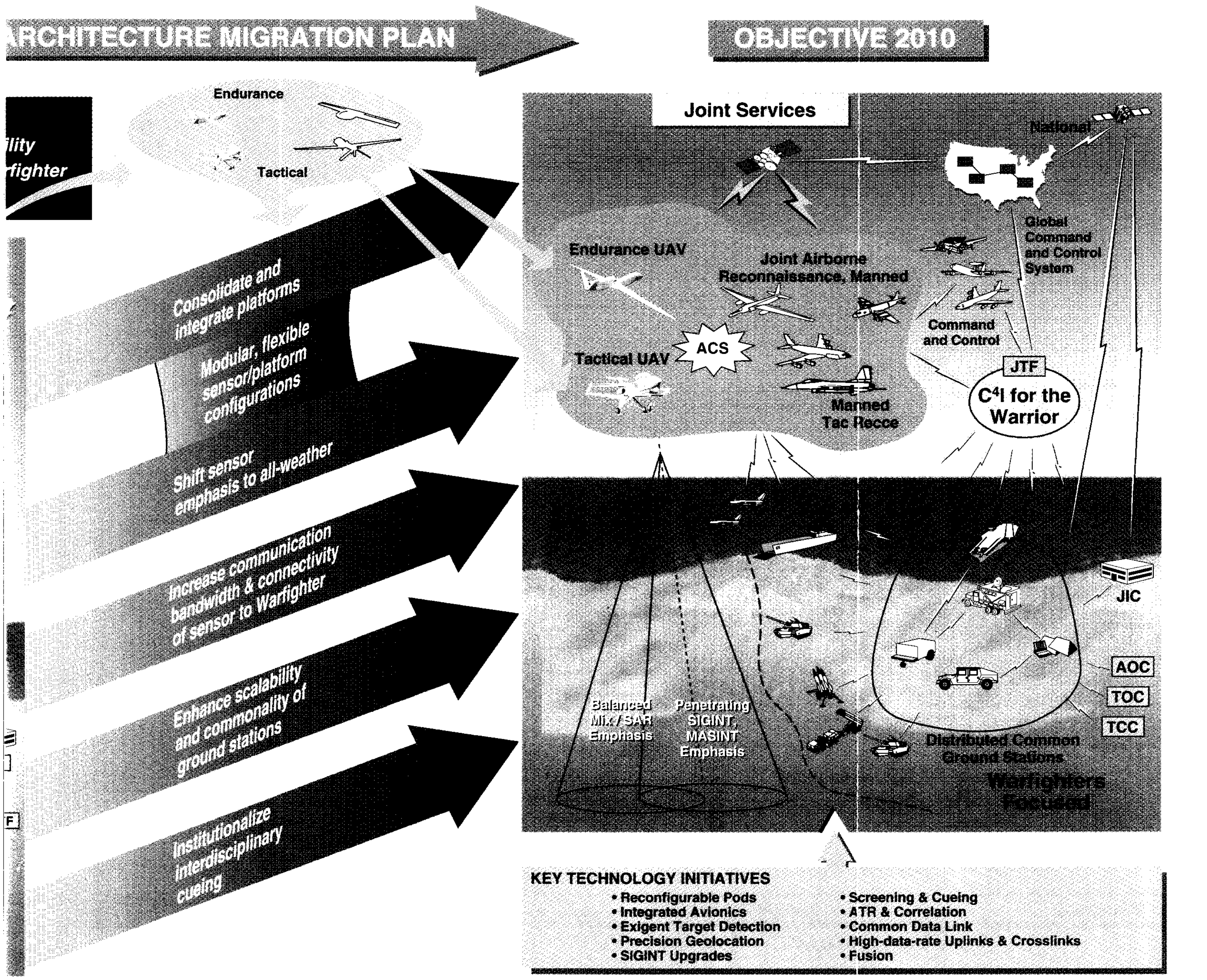

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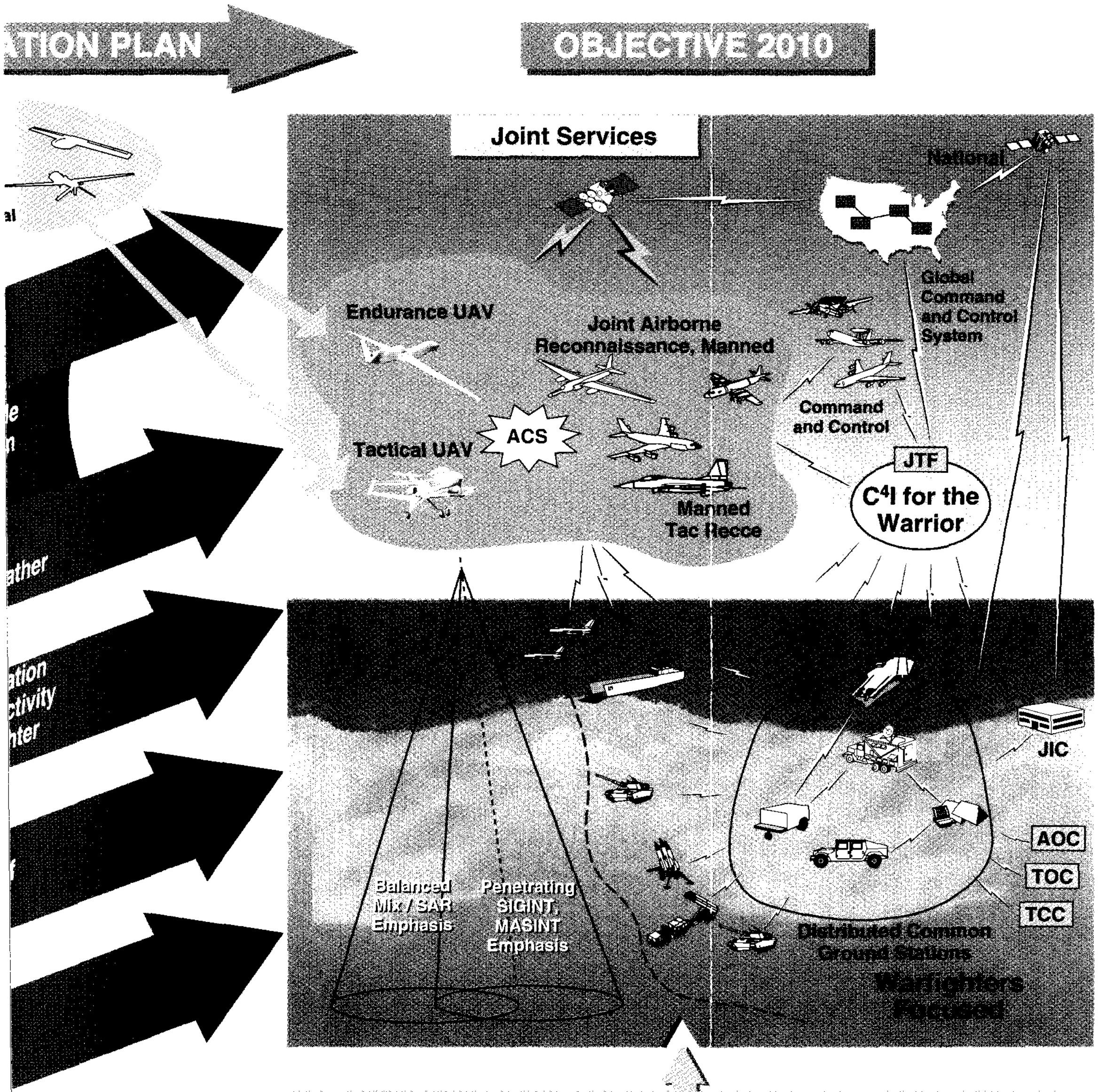
Balanced force mix to provide extended reconnaissance. Achieved by —

- *Changes in force development process, priorities and direction to c capabilities to the warfighter quickly and cost-effectively*
- *Inter/intra-theater collection and processing, communications, and balanced airborne and national contributions*

Automatic Target Recognition C4I Command, Control, Communications, Computers, and Intelligence COC Combat Operations Center JIC Joint Intelligence Center
Signatures Intelligence SAR Synthetic Aperture Radar SIGINT Signals Intelligence TCC Tactical Control Center TOC Tactical Operations Center

2



KEY TECHNOLOGY INITIATIVES

- Reconfigurable Pods
- Integrated Avionics
- Exigent Target Detection
- Precision Geolocation
- SIGINT Upgrades
- Screening & Cueing
- ATR & Correlation
- Common Data Link
- High-data-rate Uplinks & Crosslinks
- Fusion

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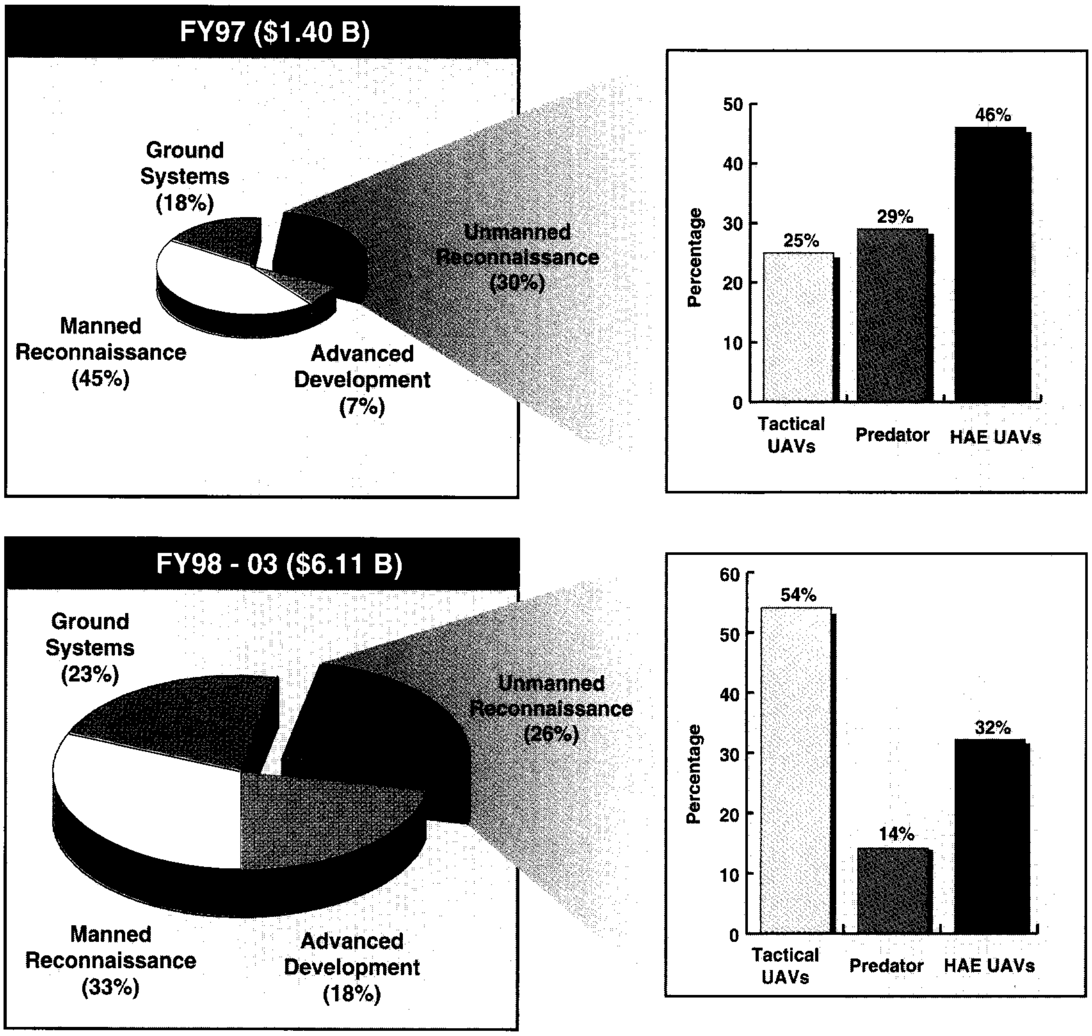
Balanced force mix to provide extended reconnaissance. Achieved by —

- *Changes in force development process, priorities and direction to deliver capabilities to the warfighter quickly and cost-effectively*
- *Inter/intra-theater collection and processing, communications, and balanced airborne and national contributions*

nd, Control, Communications, Computers, and Intelligence COC Combat Operations Center JIC Joint Intelligence Center
re Radar SIGINT Signals Intelligence TCC Tactical Control Center TOC Tactical Operations Center



UAV Share of DARP Investment
(RDT&E and Procurement Accounts)

Evolution of UAV Priorities

1995 JROC Priorities	1996 JROC Priorities
1. **Tactical UAV** (including Marinized Version)	1. **Tactical UAV** – *Outrider* – Tactical Control System – *Pioneer* (sustain as bridge to Marinized UAV)
2. ***Predator* UAV** (including Connectivity) – Marinization Feasibility Study	2. ***Predator* UAV** – Transition to production and fielding – P3I improvements (de-icing, improved IFF, UHF voice capability)
3. **High Altitude Endurance UAVs** – *Global Hawk* and *DarkStar*	3. **High Altitude Endurance UAVs** – *Global Hawk* and *DarkStar*
Based on availability timelines — Overall need is for a balanced mix	

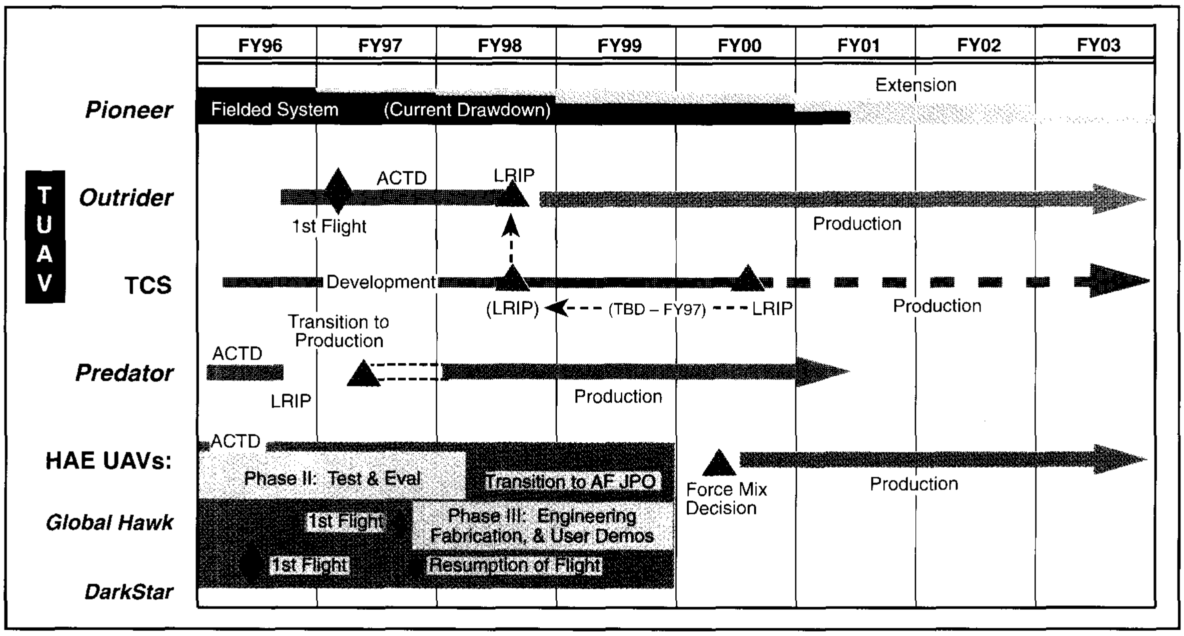
The UAV Migration Process

Migration to the airborne reconnaissance Objective Architecture for 2010 is envisioned as a 15-year process, during which architectural, programmatic and technological activities will proceed in an incremental, but coordinated process. Adjustments, however, will be necessary to meet emerging operational needs. The DoD's planning and programming processes project out-year budgets only about half that far. Accordingly, the information presented below and to the left provide planning "snapshots" of our investment strategy for UAVs as part of the evolving DARP.

UAV Summary Schedule

An integrated schedule of key UAV program milestones and interactions is depicted below. Of note, some out-year projections represent objectives for which resource allocations must still be resolved. This process is actively being addressed in both Joint Staff and acquisition community forums, as operational priorities are matched against available resources and system maturity in the planning, programming and budgeting system.

Integrated UAV Program Schedule



Resource Allocations

Basic financial projections to support the airborne reconnaissance goal of a balanced manned-unmanned force mix that is both interoperable and affordable are illustrated in the graphics to the left.

The funding "pies" indicate UAV investments will constitute over one-quarter of the DARP's $6 billion out-year budget, while manned system investments will continue to exceed UAV levels.

A breakout of the UAV segment of each pie illustrates the relative investment funding projected for tactical UAVs (*Pioneer* and *Outrider*), *Predator*, and the HAE UAVs (*Global Hawk*, *DarkStar*, and their Common Ground Segment), respectively. Pending resolution of *Predator* and HAE UAV acquisition issues through FY 2000, the lion's share of out-year investment is projected for tactical UAVs.

Future decisions may adjust these shares over time, depending primarily on the outcome of the *Outrider* and HAE UAV ACTDs. These decisions will be supported by JROC recommendations and priorities.

2

Congressional Actions

The Congress continued to be very supportive of our UAV programs during its deliberations on FY 1997 budget requests. Major funding increases for *Pioneer, Predator* and *DarkStar,* plus sustained funding for our support programs, will enable the Department to accelerate production and maintain investment levels to complete our UAV ACTDs.

Program	Increase	Congressional Guidance	Effect
Pioneer	$15M	Procurement of: • Spare and repair parts for the 9 systems • Replacement AVs and higher-reliability engines Integration of MIAG and U-CARS	Maintenance of *Pioneer's* readiness at current levels while *Outrider* is in development Avionics upgrade to improve system performance and reduce support costs
Predator	$50M	Procurement of: • 11 AVs, allocated as two systems (at 4 AVs per system, plus 3 AVs to back-fill the ACTD systems to 4 AVs per system) • 2 GCSs, and 2 Trojan Spirit II communications systems	This will greatly assist *Predator's* transition to a production program. The JROC's objective is to field 16 systems and the Congress has declared full support for this requirement
DarkStar	$28.5M	Recovery from the crash of AV #1 Purchase of long-lead components for AV #5 (to replace AV #1) Integration of EO framing technology into the aircraft and ground equipment	Timely recovery from the first AV's April 1996 mishap. Design and software corrections will be integrated into AV #2 prior to resumption of flight testing (Spring 1997)
Hunter	$12M	Removal of three systems from storage to further develop UAV concepts of operation	Expands potential for additional CONOPS development and exercise support
U-CARS	$8M	Installation of U-CARS in *Predator* and *Outrider* systems as soon as practicable	Improvement of operational performance during recovery and landing
VTOL UAV	$15M	Flight test of the *Puma* VTOL UAV	Further evaluation of VTOL technology

ACTD Advanced Concept Technology Demonstration AV Air Vehicle EO Electro-Optical GCS Ground Control Station MIAG Modular Integrated Avionics Group U-CARS UAV Common Automatic Recovery System VTOL Vertical Takeoff and Landing

Other Congressional Issues

Tactical UAVs. Congress has consistently supported the development of a UAV that can be placed directly in the hands of tactical warfighters. *Outrider* is such a system, and will be delivered for evaluation within a year of contract award.

***Predator* Marinization.** The Navy has completed the requested feasibility study on marinizing *Predator,* and the report will be delivered to Congress by early 1997. This preliminary study found that:

- *Predator* operations can be integrated with Naval air doctrine
- Full shipboard operation could be relatively costly and require significant AV modifications (to include development of a heavy-fuel engine)
- Shipboard control of (shore-based) AV and payload could support joint littoral warfare at reasonable cost, although at some reduction in responsiveness.

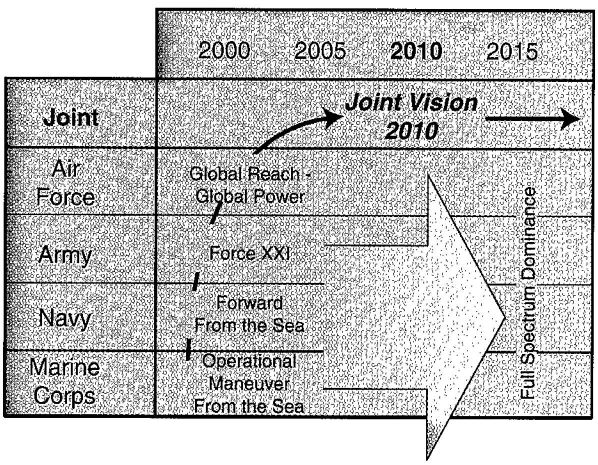
HAE UAVs. The Department examined the merits of combining *Global Hawk* and *DarkStar* as a single system, and found that the most cost-effective approach was a balanced mix of the two complementary HAE UAV systems: a highly capable, moderately survivable *Global Hawk* and a moderately capable, highly survivable *DarkStar.*

Expanding Roles for UAVs

The post-Cold War "revolution in military affairs" led to end-to-end reviews of capabilities needed for future warfare. Missions and functions cross a peace-contingency-war spectrum and the types and levels needed must be acquired in a resource-constrained environment. This new environment requires reexamination of roles and missions, resources available to support both modernization and sustainment of forces, and streamlined acquisition techniques to acquire more effective capabilities at lower cost.

Visions for Joint Warfighting

The Department's vision that will shape warfighting operational concepts for the next century has been documented in the July 1996 publication of the Chairman's *Joint Vision (JV) 2010.* With emphasis on joint warfighting, JV 2010 is the prescription for new levels of effectiveness by leveraging forces and technologies.

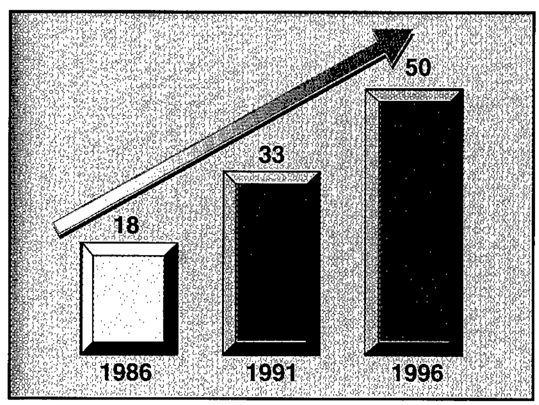


The JROC's Joint Warfighting Capability Assessment (JWCA) area that includes airborne reconnaissance is Intelligence, Surveillance and Reconnaissance (ISR).[1] JV 2010 argues that intelligence provided to our joint military commanders to support accurate delivery of precision munitions will be a principal requirement for continued military superiority. This key capability derives from an information-dependent operating environment.

In 1994, and in conjunction with the emergence of joint warfighting visions and the JWCA process, the DARO published its own vision, the *Integrated Airborne Reconnaissance Strategy,* which projected the Objective Architecture for 2010. DARO's programs are being managed to achieve this architecture, which will also conform to the Defense Information Infrastructure (DII) Common Operating Environment (COE) and the Global Command and Control System (GCCS). System technical interfaces will also comply with DARO's Airborne Reconnaissance Information Technical Architecture (ARITA) and the Joint Technical Architecture (JTA), which establish the technical interoperability "codes" for joint systems.

UAVs in Other Nations

Many of our allies and other nations have also recognized the utility of UAVs and are moving rapidly to develop their own capabilities. This offers us an opportunity and a challenge. The opportunity will come from our ability to develop and field a family of UAVs that will set the standard for performance in their class while remaining affordable. The challenge is that our UAV systems will need to interoperate with those of our allies and coalition partners to be effective in future contingency operations.



Nations with UAVs

[1] The JWCA is an eight-area functional analysis process that employs a joint, cross-Service programmatic focus to strengthen the JCS's ability to identify the best affordable joint warfighting capabilities for U.S. military forces. The ISR JWCA interacts with the other seven areas.

UAVs Over Bosnia

UAV deployments to Bosnia, in support of joint and combined operations, are the major UAV "success story" of FY 1996. They include both operational triumphs and acquisition lessons learned. Principally, they illustrate how UAVs can contribute vital information to enhance tactical operations and strategic decision-making.

Predator Deployment #1 (1995) Gjader, Albania

The first deployment, from July through November 1995, involved three *Predators* in essentially a "come-as-you-are" ACTD demo configuration, which included an electro-optical/ infrared (EO/IR) sensor, and C-band line-of-sight (LOS) and UHF SATCOM beyond-line-of-sight (BLOS) data links. Despite two early losses,[1] the *Predator* system and its operators showed steady improvements in operational practices, supportability in the field, liaison with other in-theater agencies, and the military utility of imagery products. Ad hoc taskings sometimes produced better mission results than planned "point target" taskings, and several additional steps assured better image quality.

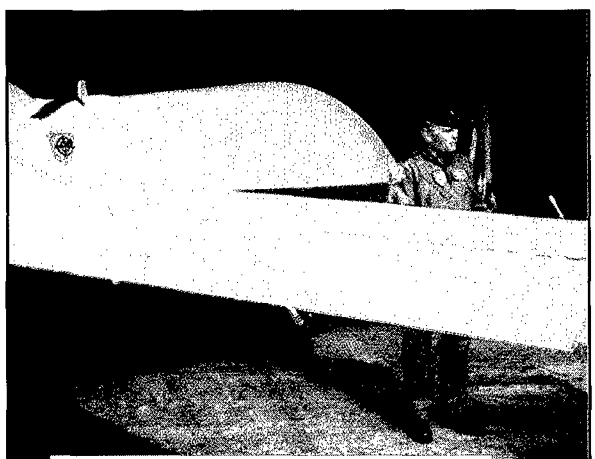
Despite its early limitations for all-weather operation, *Predator* helped determine the course of the Bosnia conflict. During September 1995, after several diplomatic and operational initiatives to relieve shelling and intimidation of civilian enclaves, especially in Bosnia's Sarajevo-Gorazde area, NATO forces resorted to active bombing to bring the warring factions to the negotiating table. Many previous agreements to remove field weapons from the area had been broken, but NATO forces could not hold the violators responsible without confirmation. With *Predator*, however, weapons movements became subject to long-dwell video surveillance, and continuous coverage of area roads showed no evidence of weaponry being withdrawn. This single ISR resource thus gave NATO commanders the key piece of intelligence that underlay their decision to resume the bombing campaign that, in turn, led to the Dayton peace accord signed in December 1995.

The needs for (1) an all-weather sensor, and (2) an all-weather flight capability, were clearly demonstrated. Other needs included a more robust communication link throughput, improved data dissemination to better exploit the near-real-time imagery products, the ability for UAV pilots to talk directly to air traffic control agencies, and a full IFF capability for the UAVs.

Predator Deployment #2 (1996) Taszar, Hungary

When another three *Predators* deployed on 1 March 1996, they were in a final ACTD configuration, which included:

- A synthetic aperture radar (SAR) sensor, as well as the basic EO/IR payload;
- A Ku-band SATCOM BLOS link, as well as the original C-band and UHF SATCOM links;
- Ice-mitigation features to reduce the risks of flying in poor weather;[2] and
- A progressively expanding information dissemination infrastructure, to provide theater-wide and international access to imagery products.



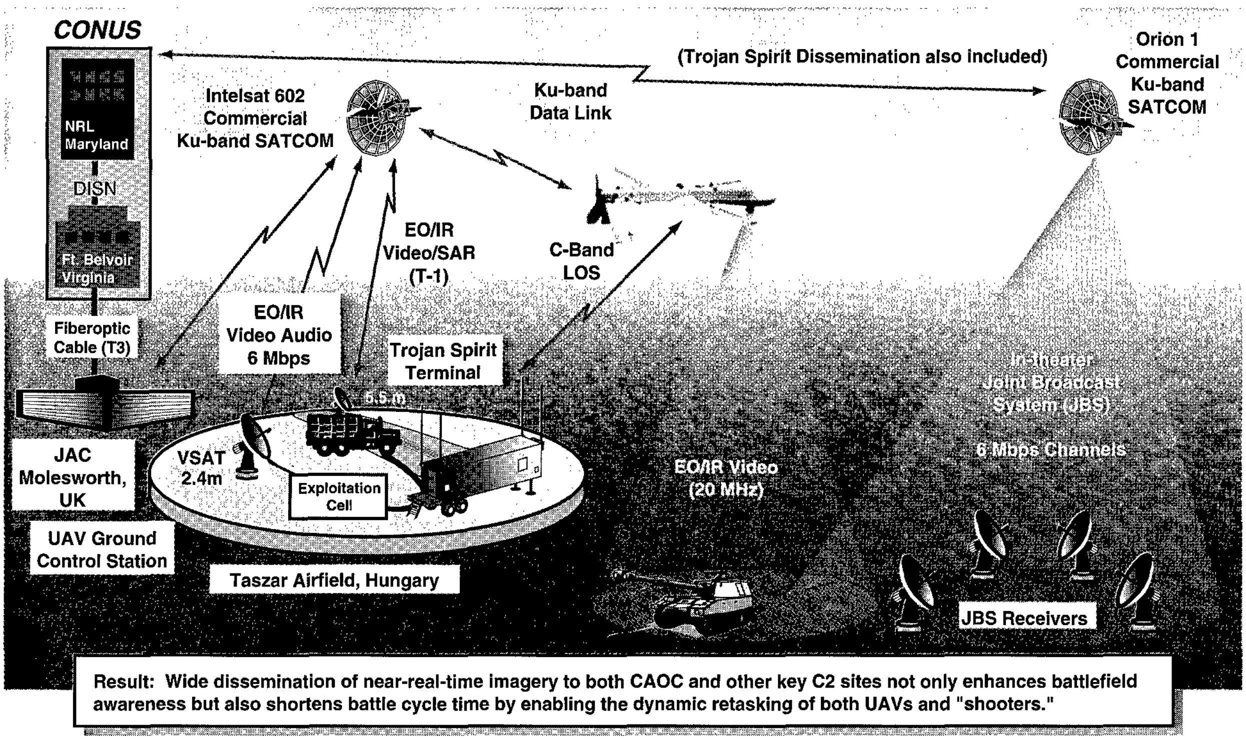
LtGen Bethurem, Commander, AIRSOUTH, presides over *Predator* transition ceremony at Taszar, Hungary, 2 Sep 96

[1] One *Predator* was lost from hostile fire, the other from engine failure.

[2] Active de-icing capabilities were installed in late-1996, and will be part of the production baseline.

Continuing Support for Joint- and Combined-Force Contingencies

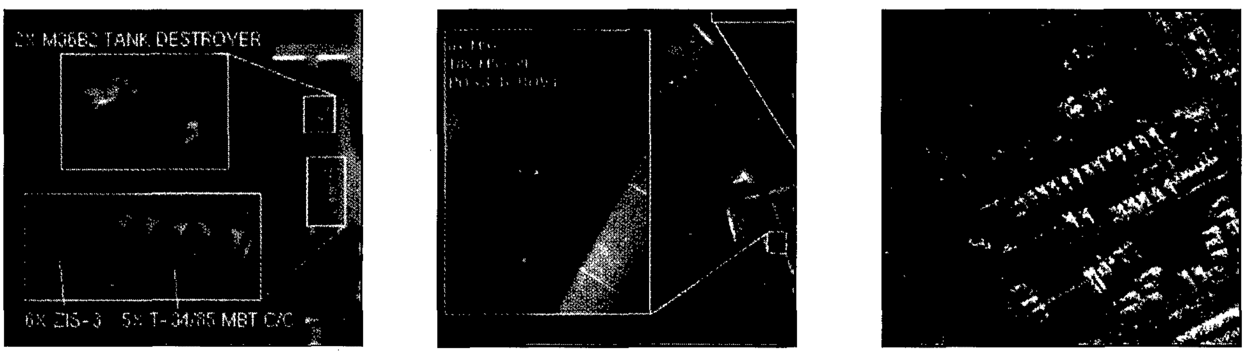
Even more significant than the *Predator* performance "firsts" is the wide use made of its imagery, amplified by the increased network of receiving stations — both in-theater and back in CONUS. The development of this dissemination capability is shown below. It first used VSATs at selected receiving sites, and then the SATCOM-based Joint Broadcast System (JBS).[3]



CAOC Combat Air Operations Center   DISN Defense Information System Network   JAC Joint Analysis Center
NRL Naval Research Laboratory   VSAT Very Small Aperture Terminal

The Predator-JBS network represents the first time for the simultaneous broadcast of live UAV video to more than 15 users. This provided a common picture of the "battlefield." Video imagery can be viewed either as full motion video or (as the cover shows) via a "mosaicking" technique at the ground station. Examples of single-frame *Predator* imagery are shown below.

Bosnia Imagery



EO **IR** **SAR**

[3] The JBS is a combined effort by the DARO, National Reconnaissance Office (NRO), Defense Information Systems Agency (DISA), and other DoD agencies.

UAVs Over Bosnia (Cont'd)

Pioneer Deployments (1995 – 96)

During their ten-year history of supporting contingency operations world-wide, *Pioneers* have deployed three times in support of Bosnia, twice afloat and once on land.

Navy VC-6 Pioneer systems have supported Sixth Fleet operations in the Mediterranean and Adriatic Seas since 1994. Most recently, one system deployed aboard USS Shreveport (August 1995 – February 1996) and flew three missions over Bosnia in January. Another deployed aboard USS Austin in July 1996 in support of fleet operations, and is available for contingencies ashore as needed.

On 12 June 1996, the 1st Marine UAV Squadron (VMU-1) deployed one *Pioneer* system to Tuzla, Bosnia, to support peacekeeping operations. They flew more than 30 missions before returning to the U.S. in October 1996.

Today, *Pioneer* is the Department's only marinized UAV for the near term to support contingencies.

Key *Predator* Accomplishments

- **Jul 95**: Deployed to Gjader, Albania, to support UN operations, monitor hostilities
- Aided search for downed pilots
- Imagery proved Serbs had not withdrawn forces threatening Sarajevo and Gorazde
- Imagery helped NATO target resulting air strikes, provided real-time BDAs
- **Nov 95**: Returned to U.S.

- **Mar 96**: Deployed to Taszar, Hungary, to support NATO peacekeeping operations and monitor belligerents
- Routine flight in congested airspace, across two national boundaries; control by AWACS in operations area
- Passed video imagery to Joint STARS ground station module in Hungary – first UAV-Joint STARS interoperation. (Live cross-cueing operations planned, but weather & Joint STARS' departure from theater intervened)
- During late Summer /early Fall of 1996, monitored mass grave sites near Sarajevo, which provided evidence of 1995 massacres
- **Sep 96**: Monitored the Bosnia election activities
- Quick-response observations to preclude confrontations between Bosnia factions or with NATO units
- **Oct 96**: Covering and monitoring of deploying forces

Key *Pioneer* Accomplishments

- **Aug 95**: VC-6 deployed aboard USS Shreveport to support fleet operations
- **Jan 96**: Flew three sorties over Bosnia in support of Implementation Force (IFOR) and Marine Expeditionary Unit (MEU) requirements
- Successfully demonstrated video retransmission to the command ship (USS Wasp) to support amphibious task force and landing force commanders (CATF/CLF)
- **Feb 96**: Returned to U.S.

- **Jun 96**: VMU-1 deployed to Tuzla, Bosnia, to support Task Force Eagle commander
- Real-time imagery provided via *Pioneer's* Remote Receiving Station (RRS) directly to IFOR units
- Task Force Eagle demonstrated dynamic retasking, using *Pioneer*
- Surveillance of population centers, suspected terrorist training areas, and route reconnaissance
- **Oct 96**: Returned to U.S.

- **Jul 96**: VC-6 deployed aboard USS Austin to support fleet operations, be available for contingencies

On 2 September 1996, at Taszar, Hungary,
the 11th Reconnaissance Squadron of the Air Force's Air Combat Command (ACC)
assumed operational control of Predator assets.

... We received an inkling of what combat will look like in the 21st century during Desert Storm and more recently in our support of NATO action in Bosnia. In both cases, unmanned aerial vehicles have demonstrated the ability to provide continuous real-time battlefield surveillance.

Dr. Paul G. Kaminski, USD(A&T)
Statement before the House Permanent Select Committee on Intelligence on Enabling Intelligence Technologies for the 21st Century, 18 October 1995

UAV Program Overview

Outrider

The most significant programmatic action of FY 1996 was the restructuring of the Joint Tactical UAV Program to the Tactical UAV Program. The award of the *Outrider* ACTD program contract in May 1996 clearly demonstrated the Defense Department's commitment to fielding a tactical UAV to support brigade/regimental and potentially maritime operational needs. The first flight will occur within six months of contract award, first system delivery within a year, and low-rate initial production (LRIP) is planned to begin 24 months after award, i.e., immediately following the end of the ACTD program. We plan to fund 62 systems by FY 2004.

Predator

Second, the transition of *Predator* from an ACTD to a production program occurred during this time frame. The Air Force committed Operations and Maintenance (O&M) funds and manpower billets to fully support the *Predator* system, as directed by the JROC. At a 13 June 1996 meeting at Langley AFB, Air Combat Command (ACC) outlined sustainment needs for the *Predator* program. Its program costs per system were baselined to include four AVs, one ground control station (GCS), one Trojan Spirit II dissemination system, and spares. The SecDef designated the Air Force as lead Service, U.S. Atlantic Command (USACOM) as Combatant Command, and the Navy as the acquisition agent.*

Pioneer

Third, with the restructuring of the Joint Tactical UAV Program, it became evident that *Pioneer's* phase-out needed to be extended from FY 2000 to FY 2003. More resources are now required to sustain *Pioneer* at its current level of readiness for nine systems through FY 1999, with phased decreases thereafter.

HAE UAVs

Fourth, within the HAE UAV ACTD, managed by DARPA, both UAVs are making progress. *DarkStar* is recovering from the loss of its first AV (which will be replaced by AV #2 in the flight test program), and *Global Hawk* has completed fabrication of AV #1 and is proceeding with ground tests and checkout in preparation for a planned first flight in 3Q/FY 1997. Additionally, the program is on track to produce a fully integrated Common Ground Segment capability for the HAE UAV system in 1Q/FY 1998.

Program	FY95 Status	FY96 Programmatic Action:
Pioneer	Fielded system	• Service life to be extended
Hunter	LRIP	• Contract allowed to expire; some assets operating, the rest stored
Maneuver UAV	RFP in preparation	• Reconstituted as the Tactical UAV (TUAV) ACTD, or *Outrider*
Predator	ACTD program	• ACTD completed; transitioning to LRIP program
Global Hawk	In HAE UAV ACTD	• ACTD continuing
DarkStar	In HAE UAV ACTD	• ACTD continuing

**The Air Force is designated as the lead Service for operating and maintaining the Predator UAV at the conclusion of the Advanced Concept Technology Demonstration, as recommended in JROC Memo 151-95. United States Atlantic Command will be the Combatant Command and the Navy Service Acquisition Executive will have responsibility for system development and procurement.*

Dr. William J. Perry, SecDef
Memorandum for Secretaries of the Military Departments (et al.)
on Assignment of Service Lead for Operation of the Predator UAV, 9 April 1996

UAV Management

DARO has responsibility for overseeing the management of UAV funding and acquisition. By charter, it is the DoD's focal point for airborne reconnaissance acquisition matters, to include architectures, budget, finances, fiscal plans, system-level trade-offs, and commonality and interoperability issues. As an Office of the Secretary of Defense (OSD) organization, DARO forwards key issues and recommendations to the Defense Airborne Reconnaissance Steering Committee (DARSC), which is a DoD-wide corporate body co-chaired by the USD(A&T) and the Vice Chairman of the JCS (VCJCS). USD(A&T) is the decision authority for airborne reconnaissance acquisition.

For operational matters, the JCS is responsible for validating UAV operational requirements through the JROC UAV Special Study Group (SSG). The UAV SSG chairmanship rotates among the Services and reports to the JROC through the Joint Staff's Director for Force Structure, Resources & Assessment (J-8). From May 1995 through November 1996, the JROC has issued 13 memoranda (JROCMs) regarding UAVs, both to support OSD program decisions and to address military requirements and priorities. These memoranda are identified below. The JROC also sponsored the Reconnaissance Study Group (RSG), which was constituted to ascertain the costs and benefits of airborne reconnaissance assets (see page 43).

JROCM-	Date	Highlights
062-95	9 May 95	Designated USACOM as HAE ACTD lead CINC
069-95	19 May 95	Addressed SSG charter and actions regarding *Hunter, Predator,* and endurance UAVs
125-95	13 Oct 95	Endorsed redesignation of Maneuver UAV as an ACTD, and requested acceleration
126-95	13 Oct 95	Recommended ending the *Hunter* program "by allowing the current contract to expire"[1]
131-95	26 Oct 95	Identified UAV priorities (see p. 4, 1995 JROC Priorities), and recommended development of a common, interoperable UAV ground reception, processing & control system (which became TCS)
135-95	31 Oct 95	Reiterated JROC's tactical UAV requirements, endorsed the ACTD approach, and sought focus on "a single best platform" within a $300,000/AV target cost[2]
150-95	15 Dec 95	JROC definition of Tactical UAV ACTD requirements
151-95	16 Dec 95	Recommended the Air Force as Service lead for *Predator,* with USACOM to continue as Combatant Command, the UAV JPO to retain responsibility for system development and procurement, and the Navy to lead if a marinized version evolved[3]
004-96	17 Jan 96	Directed the DARO to work with DARPA and PEO(CU) to assure UAV interoperability
010-96	12 Feb 96	Endorsed *Predator's* transition to production; recommended 16 systems, plus spares. Identified system upgrades and need for interoperability with TCS
016-96	4 Mar 96	Recommended that DARO await JROC's payload prioritization to support initiatives
064-96	28 May 96	Asked the Services (and CINCs via msg) to prioritize UAV mission areas/capabilities as inputs to the SSG's payloads prioritization process
173-96	12 Nov 96	Updated UAV priorities: #1: Tactical UAV (remains JROC's highest priority; also, maintain *Pioneer* as "bridge" and accelerate TCS development to parallel *Outrider's* and also support *Predator*) #2: *Predator* (transition/fielding to meet the MAE requirement; 16 systems required) #3: HAE UAVs (with Air Force as lead Service, and CGS as HAE UAV ground station

1 Implemented via USD(A&T) memo of 31 January 1996.
2 Tactical UAV ACTD approved by USD(A&T) Acquisition Decision Memorandum of 21 December 1995.
3 Implemented via SecDef memo of 9 April 1996.

Tactical

To support: Army battalions, brigades, and light divisions; Marine regiments; and deployed Navy units – Near-real-time reconnaissance, surveillance and target acquisition (RSTA), and battle damage assessment (BDA)

Pioneer & Hunter

Costs	*Pioneer*	*Hunter*
FY96	$28.3M	$38.0M[a]
FY97	$25.6M	$12.0M[b]

[a]Reprogramming in process [b]Addition to Army O&M

Program Requirements/Objectives

- Operate up to 15,000 ft and at ranges ≥ 100 nm
- ***Pioneer***: Interim IMINT for tactical commanders. Operations to be extended until TUAV is fielded
- ***Hunter***: Originally developed to meet Short Range requirement, support corps/division & naval operations with IMINT for tactical commanders

Acquisition Strategy

- ***Pioneer***: Contractor: Pioneer UAV, Inc. Sustain nine systems; current acquisition of attrition spares and AVs; plan extension through FY 2003, vice FY 2000
- ***Hunter***: Contractor: TRW. Initial contract expired with delivery of seven LRIP systems: Army maintains one at Ft. Hood, TX, to support CONOPS development including Force XXI and sufficient assets at Ft. Huachuca for training

Major Accomplishments

- ***Pioneer***: Deployed on three Navy LPD-class ships. Readiness Improvement Program continuing. Marine VMU-1 deployed to Bosnia. VC-6 deployed on USS Shreveport, USS Austin, and USS Denver
- ***Hunter***: Since flying resumed (Feb 96), *Hunter* has flown 1,050+ hours without a hardware or software failure, and has supported key exercises, demos, and tests

Outrider (TUAV)

Costs	*Outrider*[c]
FY96	$71.9M
FY97	$64.6M

[c]Includes CSD, TCS

Program Requirements/Objectives

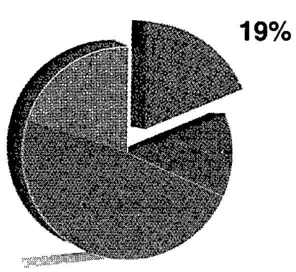
- **Cost:** $350,000 @ 33rd AV, $300,000 @ 100th AV, with sensor
- Operate ≥ 200 km range, with >4 hrs on station
- Compliance w/Joint Integration Interface standards
- Demonstrate military utility for reconnaissance and surveillance, tactical situational awareness, gun fire support, BDA

Acquisition Strategy

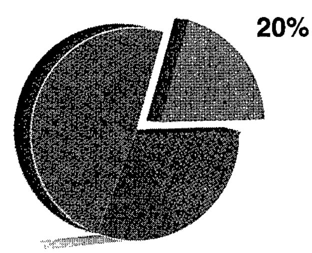
- Contractor: Alliant Techsystems
- 24-month ACTD: 6 systems and support. Focus on system integration, shipboard & interoperability demos, exercise support, and logistics definition
- 18-month LRIP option: 6 systems and support. Continued integration, testing, exercise support, and logistics development

Major Accomplishments

- ACTD contract award 2 May 96
- Inertial navigation system developed
- Prototype system delivered to System Integration Lab (SIL), Huntsville, AL
- First ACTD flight on schedule for mid-Nov 96



SHARE OF FY96 DARP UAV INVESTMENT ($354M)



AV	Air Vehicle	CSD	Common System Development	IMINT	Imagery Intelligence
LPD	Landing Platform Dock	TCS	Tactical Control System	VTOL	Vertical Takeoff and Landing

Endurance

To support: Joint Task Force Commanders and Theater/National C2 nodes; goal of sensor-to-shooter interface – Long-range, long-dwell, near-real-time theater/tactical intelligence via deep penetration/wide-area surveillance

Predator (MAE UAV)

	Predator
FY96	$44.9M
FY97	$121.9M[d]

[d]Includes U-CARS integration

Program Requirements/Objectives

- Long-range/dwell, near-real-time tactical intelligence, RSTA, and BDA
- Operate up to 25,000 ft and at radius up to 500 nm
- EO/IR and high-resolution SAR for IMINT

Acquisition Strategy

- **ACTD:** Contractor: General Atomics. Determine optimal technical approach for endurance UAVs; maintain production base following first 10 AVs
- **Production**: Baseline configuration (to include de-icing, IFF, and voice radio relay) and P3I
- **Basing**: Assigned to Air Combat Command

Major Accomplishments

- 30-month ACTD completed 30 Jun 96
- Military utility validated in demos and two contingency deployments
- Two deployments to Bosnia (Jul–Nov 95 and Mar 96-on) to support UN, NATO
- Interoperability demos with U.S. Customs Service, Navy battle group, and Navy submarine/SEAL operation
- First ACTD approved for transition to production
- Ops responsibility passed to Air Force 2 Sep 96
- Marinization study complete 1Q/FY 1997

HAE UAVs (CONV & LO HAE)

Costs	*Global Hawk*	*DarkStar*	HAE CGS
FY96	$55.4M	$65.3M	$50.2M
FY97	$71.2M	$45.9M	$71.6M

Program Requirements/Objectives

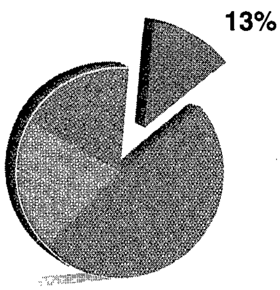
- Military utility w/UFP ≤$10M (FY94 $), AVs #11–20 (average)
- RSTA w/hi-alt, long-range/dwell & wide-area surveillance
- *Global Hawk*: 24 hrs at 65,000 ft and 3,000 nm radius
- *DarkStar*: >8 hrs at >45,000 ft and 500 nm radius

Acquisition Strategy

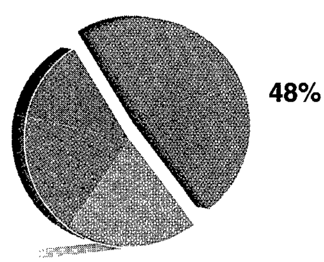
- **ACTD**: Two HAE AVs with CGS to explore military utility and roles/capabilities (USACOM as lead-CINC). DARPA used Other Agreements Authority to streamline contracting and conduct tech demos
- *Global Hawk*: Competitive award to Teledyne Ryan
- *DarkStar*: Sole-source development by Lockheed Martin
- **Demo Eval**: Demo military utility (FY 1998-1999)
- **Production**: Planned for FY 2000 (post-ACTD)

Major Accomplishments

- *Global Hawk*: Final design review (May 96); AV #1's wing loading test (Jun 96), fabrication complete (Sep 96), subsystem integration and checkout (Oct-Dec 96); 1st flight on schedule for 3Q/FY 1997.
- *DarkStar*: 1st flight 29 Mar 96; AV crash during 2nd flight (22 Apr). RCS test complete (Jul 96); system configuration review (Sep-Nov 96). (To resume flight test schedule in 3Q/FY97)
- **HAE CGS**: MCE virtual prototype experiment (May 96); LRE completing assembly and checkout (Nov 96)



SHARE OF FY96 DARP UAV INVESTMENT ($354M)

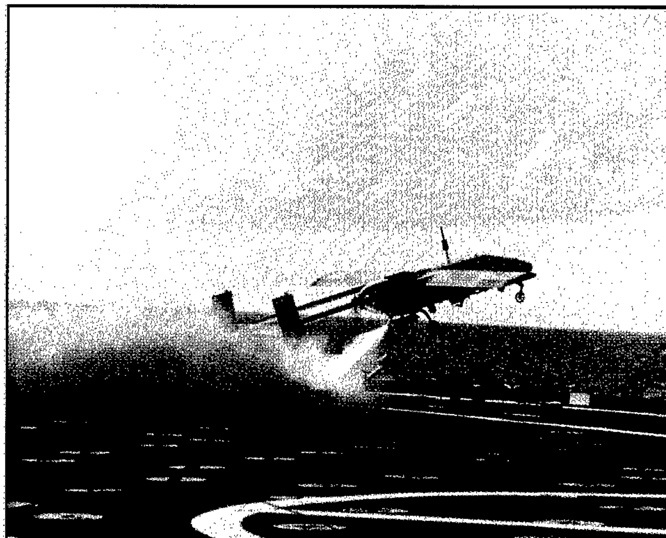


AEW	Airborne Early Warning	LRE	Launch and Recovery Element	MCE	Mission Control Element
RCS	Radar Cross-Section	U-CARS	UAV Common Automatic Recovery System	UFP	Unit Flyaway Price

Pioneer UAV Program

General

Pioneer was procured starting in 1985 as an interim UAV capability to provide imagery intelligence (IMINT) for tactical commanders on land and at sea (originally launched from Navy Iowa-class battleships, today from LPD-class ships). In ten years, *Pioneer* has flown nearly 14,000 flight hours and supported every major U.S. contingency operation to date. It flew 300+ combat reconnaissance missions during Persian Gulf operations in 1990-91. Since September 1994, it has flown in contingency operations over Bosnia, Haiti and Somalia; most recently it flew in Task Force Eagle and IFOR operations again over Bosnia. Prime contractor is Pioneer UAV, Inc., Hunt Valley, MD.



SUBSYSTEMS

- 5 Air Vehicles
- 1 Ground Control Station
- 1 Portable Control Station
- 4 Remote Receiving Stations (max)
- 1 Truck-Mounted Launcher

KEY OPERATIONAL FACTORS

Sensors:	EO or IR
Deployment:	Multiple* C-130/C-141/C-17/C-5 sorties; also shipboard
Radius:	185 km (100 nm)
Endurance:	5 hrs
Max Altitude:	4.6 km (15,000 ft)
Cruise Speed:	120 km/hr (65 kts)

*Depends on equipage and duration

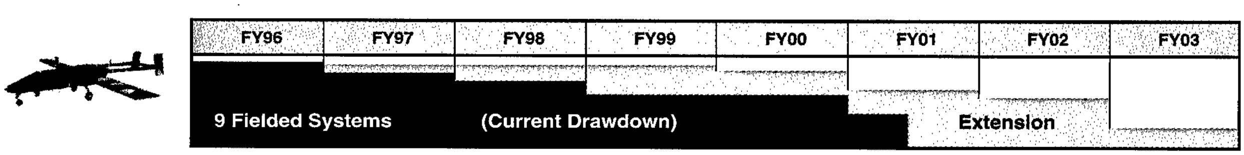
Flight Data[a]	Bosnia	FY96	Total to Date
• Flights / Hours	33 / 89	629 / 1,554	4,000+ / 13,798

[a]As of 30 Sep 96

Funding ($M):	FY96	FY97
Procurement (Defense-wide)	28.3	
Procurement (Navy)		25.6

Program Status

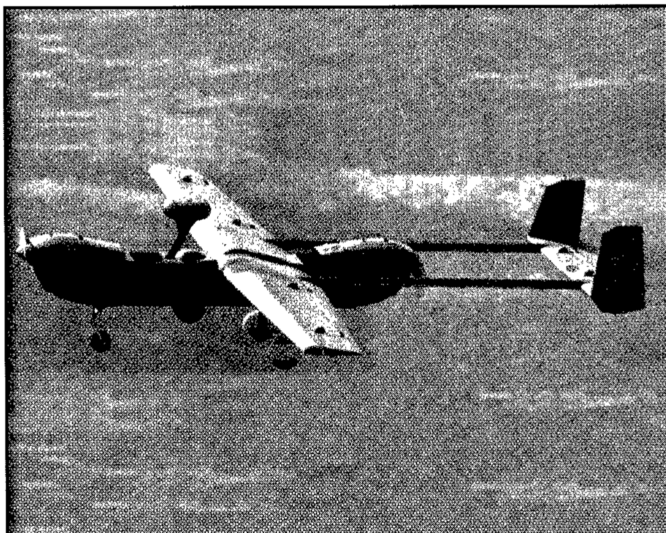
Pioneer continues to operate as the DoD's first operational UAV system. Currently, there are nine systems in the active force: the Navy operates five, the Marine Corps three, and one is assigned to the Joint UAV Training Center (JUAVTC) at Ft. Huachuca, AZ. The Navy system at Patuxent River Naval Air Station (NAS), MD, supports software changes, hardware acceptance, test and evaluation of potential payloads, and technology developments to meet future UAV requirements (see p. 40). An additional 30 *Pioneers* (procured in FY 1994) were delivered from September 1995 through November 1996, along with continuing support kit and spares procurement. These aircraft are in the Option 2+ configuration, which has slight increases in air vehicle weight and fuel capacity. A third extension of the *Pioneer* force's operational life is being planned through FY 2003, until TUAV systems are fielded and able to meet tactical-level UAV requirements. During FY 1996, one Marine unit deployed to Tuzla, Bosnia, to support peacekeeping operations ashore, and two Navy units successively deployed aboard USS Shreveport and USS Austin to support fleet operations and contingency operations ashore as needed.



Hunter UAV Program

General

The *Hunter* Joint Tactical UAV was originally developed to provide both ground and maritime forces with near-real-time IMINT within a 200-km direct radius of action, extensible to 300+ km by using another *Hunter* as an airborne relay. *Hunter* can operate from unimproved air strips to support ground tactical force commanders. Prime contractor is TRW, San Diego, CA.



SUBSYSTEMS

8 Air Vehicles
4 Remote Video Terminals
3 Ground Control/Mission Planning Stations
2 Ground Data Terminals
1 Launch & Recovery System
1 Mobile Maintenance Facility

KEY OPERATIONAL FACTORS

Sensors:	EO and IR
Deployment:	Multiple* C-130 sorties
Radius:	267 km (144 nm)
Endurance:	11.6 hrs
Max Altitude:	4.6 km (15,000 ft)
Cruise Speed:	>165 km/hr (>89 kts)

*Depends on equipage and duration

Flight Data[a]	FY96	Total to Date
• Flights / Hours	350 / 1,051	1,575 / 4,590

[a]As of 30 Sep 96

Funding ($M):	FY96	FY97
Procurement (Defense-wide)	38.0[b]	
Opns & Maintenance (Army)		12.0[c]

[b]Reprogramming to TUAV/TCS, *Predator* and *DarkStar* RDT&E in process
[c]Addition to Army O&M Account

Program Status

Following an October 1995 JROC recommendation, in January 1996 the USD(A&T) decided to let *Hunter's* contract expire after delivery of its seven LRIP systems. Currently, the Army is operating a single *Hunter* system at Ft Hood, TX, to support operations, concept development, and continuation training; additional assets support initial operator and maintainer training at the Joint UAV Training Center (JUAVTC) at Ft Huachuca, AZ, and interoperability, test and evaluation work at the Joint UAV Systems Integration Laboratory (SIL) at Huntsville, AL. All other *Hunter* equipment remained in Army storage.

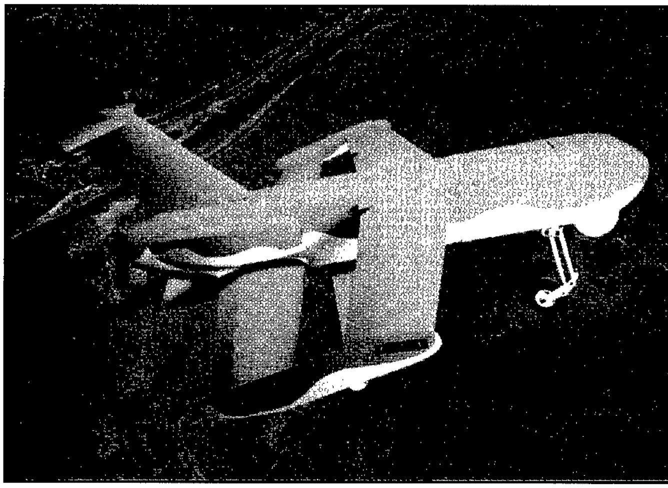
Hunter resumed flight operations in February 1996 at Ft Hood and in April at Ft Huachuca. As of 30 September, it has flown 1,050+ hours in support of Army and joint operations and training, and payload testing. In April, a *Hunter* demonstrated a VHF/UHF radio relay capability between two ground stations. In July, *Hunters* deployed from Ft Hood to support tactical warfighter training at the National Training Center (NTC), Ft Irwin, CA, where they flew nearly 200 hours supporting reconnaissance, surveillance, live-fire and maneuver operations. In an August live-fire demonstration at Eglin AFB, FL, a *Hunter* was a testbed for a laser designator demo. In September, *Hunter* successfully demonstrated several payloads for the Joint Command and Control Warfare Center (see page 39).

For FY 1997, the Congress provided an additional $12 million to the Army "to remove three *Hunter* systems from storage to provide a capability to further develop UAV concepts of operation."

Outrider TUAV Program

General

The *Outrider* Tactical UAV (TUAV) program is an Advanced Concept Technology Demonstration (ACTD) to support tactical commanders with near-real-time imagery intelligence (IMINT) at ranges beyond 200 km and on-station endurance greater than 4 hours. This ACTD replaces the *Hunter* and Maneuver UAV programs in seeking to provide reconnaissance, surveillance and target acquisition (RSTA) and combat assessment (CA) at Army brigade/battalion, Navy task force and Marine Corps regimental/battalion levels. The ACTD involves a two-year cost-plus contract with a low-rate initial production (LRIP) option, and is valued at $52.6 million. Prime contractor is Alliant Techsystems, Hopkins, MN.



SUBSYSTEMS

4 Air Vehicles
4 Modular Mission Payloads
2 Ground Control Stations and Data Terminals
1 Remote Video Terminal
Launch & Recovery and Ground Support Eqpt

KEY OPERATIONAL FACTORS

Sensors:	EO/IR (SAR growth)
Deployment:	Single C-130
Radius:	≥200 km (≥108 nm)
Endurance:	>4 hrs (+ reserve) @ 200 km
Max Altitude:	4.6 km (15,000 ft)
Cruise Speed:	167 km/hr (90 kts)

Funding (TUAV) ($M):	**FY96**	**FY97**
RDT&E (Defense-wide)	71.9	64.6
• *Outrider*	(47.6)	(51.4)
• Tactical Control System	(18.3)	(7.1)
• Common Systems Dev't	(5.9)	(6.1)

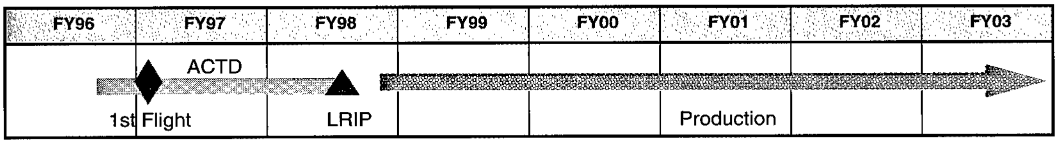
Program Status

On 21 December 1995, the USD(A&T) approved initiation of an ACTD for a single TUAV system to meet joint Service requirements. The ACTD's primary objective is to develop a joint tactical UAV that best meets basic performance requirements, as defined by the JROC, within target costs of $350,000 for the 33rd basic air vehicle (AV) with sensor and $300,000 for the 100th AV with sensor. The system must also demonstrate military utility and comply with Joint Integration Interface (JII) standards. (The Tactical Control System [TCS] concept for interoperable UAV command and control will be developed as a parallel program; see pages 24-25).

On 2 May 1996, Alliant Techsystems won the ACTD contract to develop its *Outrider* UAV system. The contract included delivery of six *Outrider* systems, eight attrition AVs, two Mobile Maintenance Facilities (MMFs), and an LRIP option for six additional systems and two additional MMFs; first flight was required in six months, first system delivery in one year, and the remaining five systems delivered during the second ACTD year. The basic *Outrider* ACTD includes the mandatory options of a heavy fuel engine (HFE) and the UAV Common Automatic Recovery System (U-CARS); non-mandatory options include incorporation of a tactical data link and a synthetic aperture radar (SAR) sensor. On 13 September 1996, the USD(A&T) reaffirmed these *Outrider* options in an Acquisition Decision Memorandum by directing risk mitigation in preparation for the acquisition of U-CARS and HFE, and an executive review of the initiatives for a SAR sensor and a tactical variant of the Common Data Link (CDL).

Support for Joint Force Tactical Operations

Schedule



Requirements

ACTD Performance Requirements*		
Parameter	**Basic**	**Option**
Range:	200 km	
Target Location Error:	Best possible using state-of-the-art GPS (NTE 100 m)	
On-Station Endurance:	3 hrs	4 hrs
Launch and Recovery:	Unprepared surface/large deck amphibious ships	Add Automatic TO&L
System Mobility:	2 HMMWVs/1 Trailer	
System Deployability:	Single C-130 (4 AVs & ground equipment)	
Payload:	EO/IR	SAR
Integration:	EMI shielding/corrosion inhibition	
Data Link:	Compliant with JII (200 km LOS at sea level)	Common Data Link
Propulsion System:	As provided by Contractor	Heavy Fuel Engine
Cost (AV & Sensor):	$350,000 at 33rd AV; $300,000 at 100th AV	

EMI Electromagnetic Interference   GPS Global Positioning System   JII Joint Integration Interface
LOS Line of Sight   NTE Not to Exceed   TO&L Takeoff and Landing

* Ref: Sec C – System Performance Document, TUAV ACTD RFP, 31 Jan 96.

Transition Integrated Product Team (IPT)

Outrider's prospective transition from ACTD to a formal acquisition program will involve a significant level of preparation. A Transition IPT, co-chaired by the ACTD Acquisition Manager and a representative from the USD(A&T)'s Advanced Technology directorate, was established in June 1996. It will ensure that the necessary preparations are made during the ACTD for an effective transition into LRIP (given a favorable decision in FY 1998). Its four working-level IPTs are focusing on the areas of requirements, military utility, supportability, and acquisition — all of which are addressing the preparations needed to achieve both operational as well as acquisition transition functions.

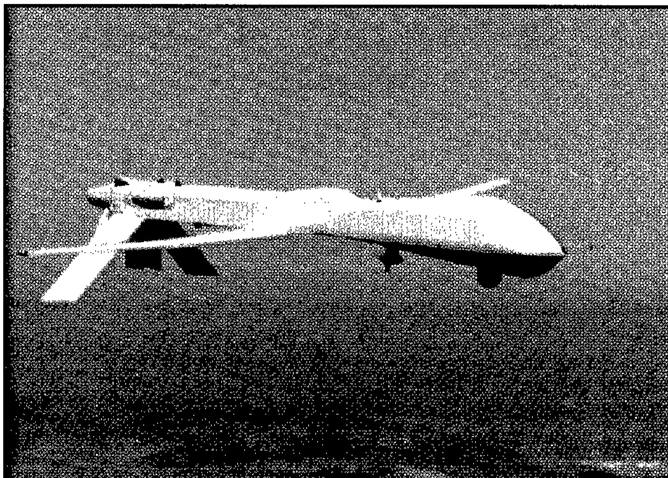
The tactical UAV is absolutely critical to our brigade and division commanders.... it is their confirming sensor, and the "eyes" which enable commanders to see critical portions of their battlefield and target anything they can see.

Lieutenant General Paul E. Menoher, Jr.
Deputy Chief of Staff for Intelligence, U.S. Army
5 August 1996

Predator (MAE UAV) Program

General

Predator, also identified as the Medium Altitude Endurance (MAE) or Tier II UAV, is a derivative of the Gnat 750 (Tier I) UAV. In July 1996, *Predator* completed its 30-month ACTD program and is transitioning to low-rate initial production (LRIP) in the formal acquisition arena. The system provides long-range, long-dwell, near-real-time imagery intelligence (IMINT) to satisfy reconnaissance, surveillance and target acquisition (RSTA) mission requirements. The air vehicle carries both EO/IR and SAR sensors which, with Ku- as well as UHF-band satellite communication (SATCOM) links, enable the system to acquire and pass imagery to ground stations for adverse weather, beyond-line-of-sight (BLOS) use by tactical commanders. Recent addition of de-icing equipment now allows transit and operation in adverse weather conditions. This capability was deployed to Bosnia in October 1996. As production assets augment ACTD assets, *Predator* will be the operational endurance UAV workhorse for the next several years. Prime contractor is General Atomics – Aeronautical Systems, Inc., San Diego, CA.



SUBSYSTEMS

4 Air Vehicles
1 Ground Control Station
1 Trojan Spirit II Dissemination System
Ground Support Equipment

KEY OPERATIONAL FACTORS

Sensors:	EO, IR, and SAR
Deployment:	Multiple* C-130 sorties
Radius:	926 km (500 nm)
Endurance:	>20 hrs
Max Altitude:	7.6 km (25,000 ft)
Cruise Speed:	120-130 km/hr (65-70 kts)

*Depends on equipage and duration

Flight Data[a]	Bosnia	FY96	Total to Date
• Flights / Hours	159 / 1,169	537 / 2,477	1,575 / 4,590

[a]As of 30 Sep 96

Funding ($M):	FY96	FY97
RDT&E (Defense-wide)	44.9	6.1
Procurement (Navy)[b]		115.8

[b]Includes $8 million for U-CARS

Program Status

After a November 1995 return from Albania and support of United Nations operations in Bosnia, *Predator* AVs incorporated both a SAR sensor (with imagery transmitted through the Ku-band SATCOM link) and initial ice sensing features to enable poor weather operation. *Predators* redeployed in March 1996 to Taszar, Hungary, supporting NATO operations in Bosnia; return is currently planned for February 1997. Concurrently, other *Predators* participated in a succession of interoperability demonstrations, specifically with the U.S. Customs Service (Fall, 1995), a Navy carrier battle group (CVBG) (Fall, 1995), and a Navy submarine with SEAL team aboard (Spring, 1996); details are on pages 32-33.

On 30 June 1996, *Predator* completed its 30-month ACTD. On 26 July, General Atomics received a $23 million contract for another five AVs and ancillary equipment. On 2 September, the Air Force Air

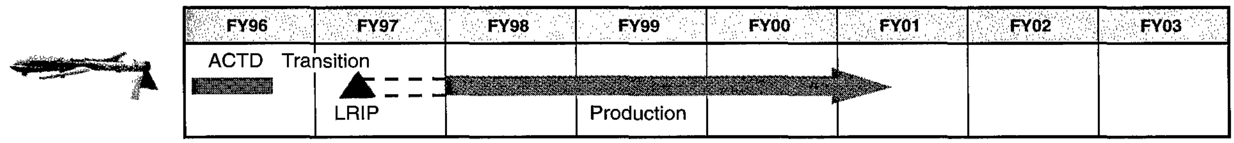
> *The Predator has proved its ability to provide a significant and urgently needed reconnaissance capability in many mission areas and the continued participation of each Service must be maintained.*
>
> *Dr. William J. Perry, SecDef*
> *Memo for Secretaries of the Military Departments (et al.)*
> *on Assignment of Service Lead for Operation of the Predator UAV, 9 April 1996*

Providing Multi-Role Support to All Operational Echelons

Combat Command's 11th Reconnaissance Squadron, Nellis AFB, NV, assumed operational control (OPCON) of assets.

In the Defense Appropriations Act for FY 1997, the Congress transferred *Predator's* production funding from the Defense-wide Procurement account to the Navy's Procurement account and increased the amount by $50 million to $115.8 million for the year (which included funding for U-CARS integration on *Predator* and *Outrider*).

Schedule



Transition and Acquisition Program Features

Predator constituted a Class II (weapon/sensor system) ACTD and will enter formal acquisition as an LRIP program. The JROC recommended an initial force of 16 systems (plus attrition spares) (JROCM 010-96), including one system for R&D, or more than 60 AVs, counting the retrofitted ACTD versions. Resource programming to support life-cycle acquisition, operations and support is ongoing and candidate capabilities are listed below. The DoD plans to continue all system development and procurement through the Navy's UAV JPO, while the Air Force manages system operations and maintenance. *Predator's* LRIP production configuration and longer-term P3I program will be more fully defined in FY 1997.

Configuration Feature	Baseline	P3I*	Remarks
De-icing system	X		Required for reliable all-weather operation
Onboard UHF voice radio	X		For BLOS communications with ATC
Improved identification friend-or-foe (IFF)	X		Positive airborne control requirement
Engine upgrade		√	Rotax 914 to replace Rotax 912
Heavy fuel engine (HFE)		√	Mandatory for a marinized *Predator*
UAV Common Auto Recovery System (U-CARS)		√	Feasibility study to be completed Dec 96
Engine and propeller quieting		√	Exhaust system muffler, variable-pitch prop
Upgraded IR sensor		√	Under study for near-term P3I
Moving target indication (MTI)		√	Under study for near-term P3I
Improved GPS		√	Under study for longer term
SATCOM suite (Trojan Spirit) replacement		√	Under study for longer term
Upgraded GCS communications suite		√	Under study for longer term
Communications relay		√	Under study for longer term
Laser designation/rangefinder		√	Under study for longer term
SIGINT payload		√	Under study for longer term

*Recommended P3I candidates

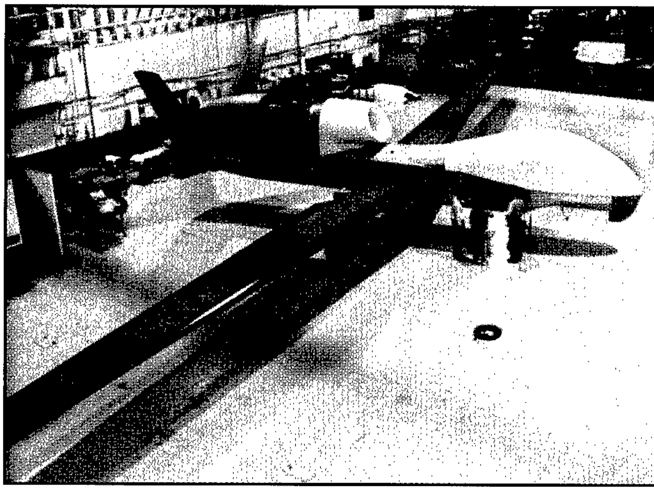
The operational capabilities embodied in the Predator UAV system are a significant first step toward the continuous, real-time Reconnaissance, Surveillance and Target Acquisition (RSTA) required by 21st century joint warfighters. ACC is committed to developing our ability to employ the family of UAVs in that role.

General Richard E. Hawley
Commander, Air Combat Command
August 1996

Global Hawk (CONV HAE UAV) **Program**

General

Global Hawk, also identified as the Conventional High Altitude Endurance (CONV HAE) or Tier II+ UAV, is intended to be employed as the HAE UAV "workhorse" for missions requiring long-range deployment and wide-area surveillance or long sensor dwell over the target area. It will be directly deployable from well outside the theater of operation, followed by extended on-station time in low- to moderate-risk environments to look into high-threat areas with EO/IR and SAR sensors in order to provide both wide-area and spot imagery; survivability will derive from its very high operating altitude and self-defense measures. The HAE Common Ground Segment (CGS) (see page 26) will provide launch and recovery and mission control elements (LRE and MCE) that are common and interoperable with *DarkStar.* Prime contractor is Teledyne Ryan Aeronautical (TRA), San Diego, CA.



SUBSYSTEMS

Air Vehicles (TBD)

1 Common Ground Segment

KEY OPERATIONAL FACTORS

Sensors:	EO, IR, and SAR
Deployment:	AV: self-deployable; multiple C-141/ C-17/C-5 sorties for other eqpt*
Radius:	5,556 km (3,000 nm)
Endurance:	>40 hrs (24 hrs at radius)
Max Altitude:	19.8 km (65,000 ft)
Cruise Speed:	639 km/hr (345 kts)

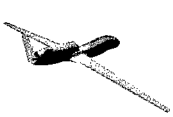
*Depends on equipment deployed and deployment duration

Funding ($M):	**FY96**	**FY97**
RDT&E (Defense-wide)	55.4	71.2

Program Status

Since contract award for Phase II in June 1995, the TRA team has fabricated the first AV and is performing subsystem and system tests. Phase II comprises an extensive fabrication and system test program to assure air vehicle-ground segment integration, demonstrate system capabilities, and reduce risk. Final design review was completed in May 1996, the wing loading test in June, full air vehicle assembly in September, and subsystem checkout continues in October. First flight is planned for Spring 1997, to be followed by a series of AV flight and system tests and initial demonstrations. Meanwhile, fabrication of AV #2 began in July 1996. Phase II will extend through 1Q/FY 1998. Phase III's operational demonstrations of the full HAE UAV system are scheduled to begin in mid-FY 1998. Program management is scheduled to transition from DARPA to an Air Force-led joint program office at the end of December 1997.

Schedule



FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03
Phase II: Test & Eval		Transition to AF JPO		Force Mix Decision	Production		
	1st Flight	Phase III: Engineering, Fabrication, & User Demos					

Deep-Look Wide-Area Reconnaissance for Commanders

Advanced System Concept

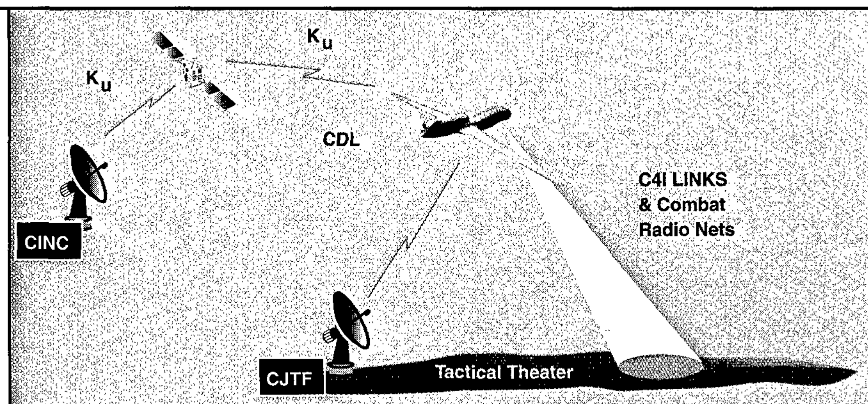
Global Hawk's role in the HAE UAV CONOPS is illustrated on page 30. Meanwhile, in light of *Predator's* wide dissemination of imagery via JBS satellites during its second Bosnia deployment, comparable scenarios are being examined for this longer-range UAV under a Global Hawk-Airborne Communications Node (ACN) system concept. The ACN concept envisions a communications node payload for a UAV to provide gateway and relay services to surface and air forces. This capability would specifically enhance long-range/endurance deployment of a HAE UAV to meet contingency requirements. Options and features are summarized below.

General:

- *Global Hawk* coverage available at H-hour (vice weeks to deploy and start operating)
- Less vulnerable (at 65,000 ft altitude, 200 km slant range) than overflight and local signal sites
- Open system architecture w/software-reconfigurable communications payload
- Exploitation of military & commercial satellite and other links and networks for wide dissemination

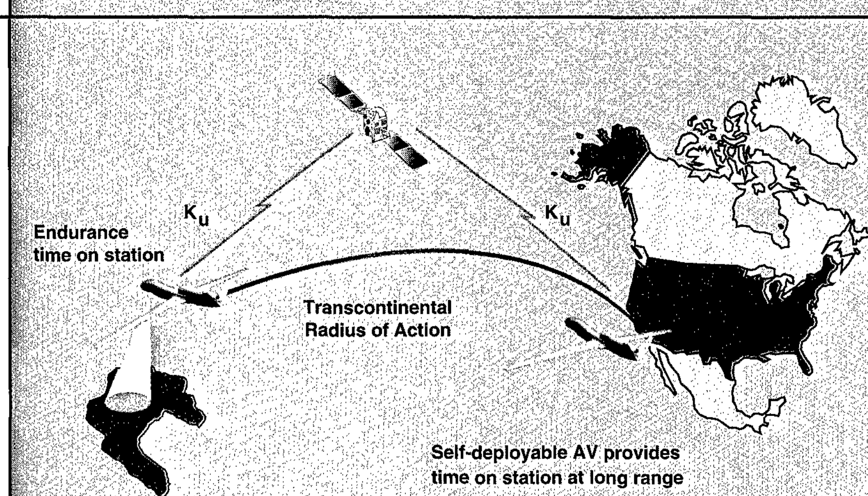
In-Theater Coverage:

- *Global Hawk* provides 500 km LOS
- Connectivity for:
  - Isolated/maneuvering forces
  - Forward elements (back to U.S.)
  - Dissimilar radios via ACN gateways
  - Developing crises without large in-theater assets
- AV self-deployment eases lift needs



Coverage from CONUS:

- Trades *Global Hawk's* 40+ hrs endurance vs. 25,000 km max range
- Intercontinental ops could involve 12+ hrs on-station (w/6,500 km round trip)
- With ≈4 hrs AV ground maintenance, 4 GH-ACN assets could cover crisis areas indefinitely from CONUS
- AV self-deployment + out-of-theater support = *no* need for lift
- Recce equivalent of strategic bombing

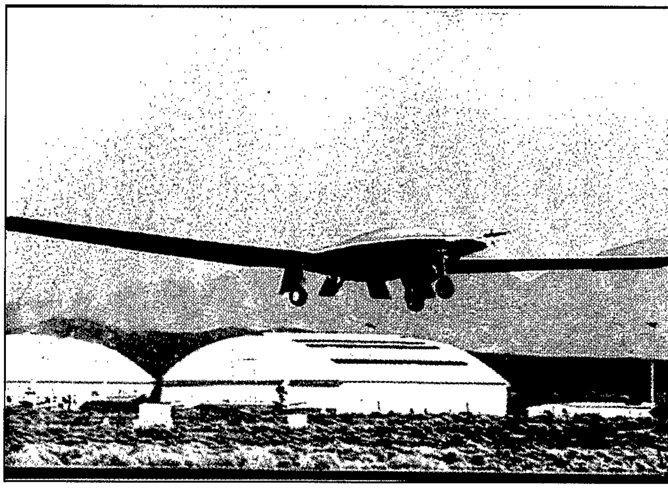


> *It all started 93 years ago with two brothers from Ohio.... Think where we will go in the next 93 years.*
>
> *General Joseph W. Ralston, USAF*
> *Vice Chairman, Joint Chiefs of Staff*
> *Address to the National Aviation Club, 9 October 1996*

DarkStar (LO HAE UAV) Program

General

DarkStar, also identified as the Low Observable High Altitude Endurance (LO HAE) or Tier III– UAV, is intended to provide critical imagery intelligence from highly defended areas. *DarkStar* trades air vehicle performance and payload capacity for survivability features against air defenses, such as its use of low observable technology to minimize the air vehicle's radar return. Its payload may be either SAR or EO. The air vehicle may be self-deployable over intermediate ranges. The HAE Common Ground Segment (CGS) will provide launch and recovery and mission control elements (LRE and MCE) that are common and interoperable with *Global Hawk. DarkStar's* prime contractor is the Lockheed Martin/Boeing team.



SUBSYSTEMS

Air Vehicles (TBD)

1 Common Ground Segment

KEY OPERATIONAL FACTORS

Sensors:	EO or SAR
Deployment:	Multiple C-141/C-17/C-5 sorties
Radius:	>926 km (>500 nm)
Endurance:	>8 hrs (at 926 km/500 nm)
Max Altitude:	>13.7 km (>45,000 ft)
Cruise Speed:	>463 km/hr (>250 kts)

Funding ($M):	**FY96**	**FY97**
RDT&E (Defense-wide)	65.3	45.9

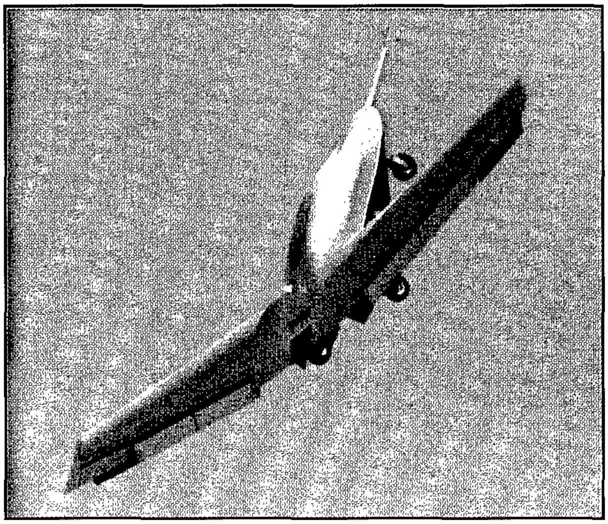
Program Status

Following its 1 June 1995 rollout and a series of ground tests, *DarkStar* flew successfully on 29 March 1996, a first fully autonomous flight using differential GPS. On its 22 April second flight, however, its "wheel-barrowing" characteristic on takeoff roll increased to uncontrollable "porpoising" oscillations after breaking ground, and the aircraft stalled nose-high and crashed. The accident board identified the cause as inaccurate prediction of air vehicle/ground interaction, which had led to an engineering change to the flight control system before the second flight. Corrective action will include "hiking" the nose gear at rotation during takeoff, simplifying flight control laws during the takeoff phase, and adding the capability to abort takeoffs. Software testing and reconfiguration of AV #2 are currently projected to allow the Phase II flight test program to resume in 3Q/FY 1997. Meanwhile, radar cross-section (RCS) test results validated *DarkStar's* low-observable design.

The Congress has provided an additional $28.5 million for FY 1997, of which $22 million supports design changes and their integration into AV #2, $3.5 million is for further EO sensor development, and $3 million is for long-lead procurement of AV #5. One effect of the program delay has been to realign *DarkStar's* flight and system test schedules to better support user demos and provide comparable *DarkStar-Global Hawk* maturity for DARO's force mix study, both of which will be key to a HAE UAV production decision in FY 2000.

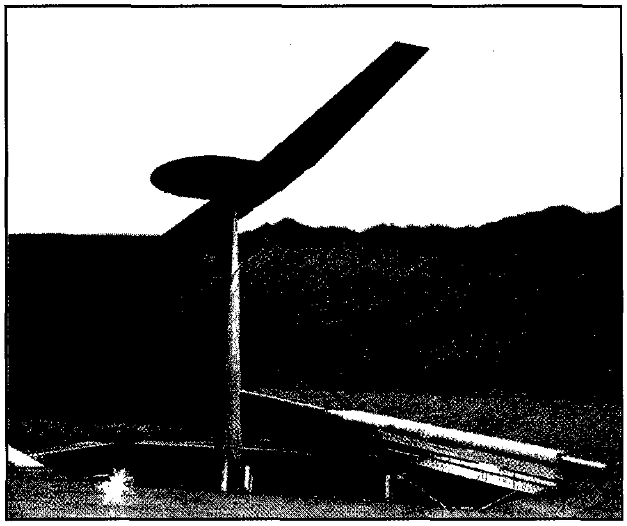
Deep-Look Reconnaissance of Highly Defended Areas

***DarkStar's* Second Flight, 22 April 1996**



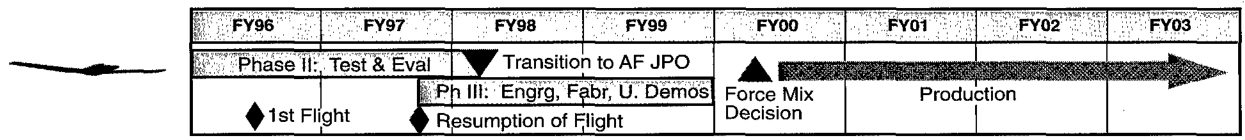
Aircraft's porpoising motion increases to a nose-high stall as it leaves the ground-effect régime

***DarkStar's* Radar Cross-Section Test**



AV #2 in position on "the pole" for RCS testing, May 1996

Schedule



The high-priority DarkStar *program will demonstrate a warfighting capability that the U.S. has not had since the early days of the SR-71 and U-2. While the program experienced an unfortunate setback with the crash last April, I am confident that it will demonstrate outstanding performance as it begins flying again in FY 1997. The* DarkStar's *ability to penetrate heavily defended areas and collect significant amounts of high-resolution imagery will provide the Joint Forces Commander with unprecedented access to battlefield information.*

Larry Lynn
Director, Defense Advanced Research Projects Agency
October 1996

The HAE UAV System

DarkStar and *Global Hawk,* with their Common Ground Segment (see page 26), form the HAE UAV system. The two air vehicles are complementary: *DarkStar* will provide a capability to penetrate and survive in areas of denied airspace, while *Global Hawk's* even greater range, endurance and multi-sensor payload will provide broad battlefield awareness to senior command echelons. Their CGS will assure both their interoperability and relay of their sensor products to the C4I infrastructure. Thus, the HAE UAV system will provide the joint warfighter with an unprecedented degree of broad reconnaissance-surveillance coverage and flexibility.

Ground Station Programs

The Department is developing two UAV ground control station (GCS) types: the Tactical Control System (TCS) for tactical UAVs, and the Common Ground Segment (CGS) for the HAE UAVs (see page 26). The key reason for two GCS types is to support system requirements for two complementary UAV classes:

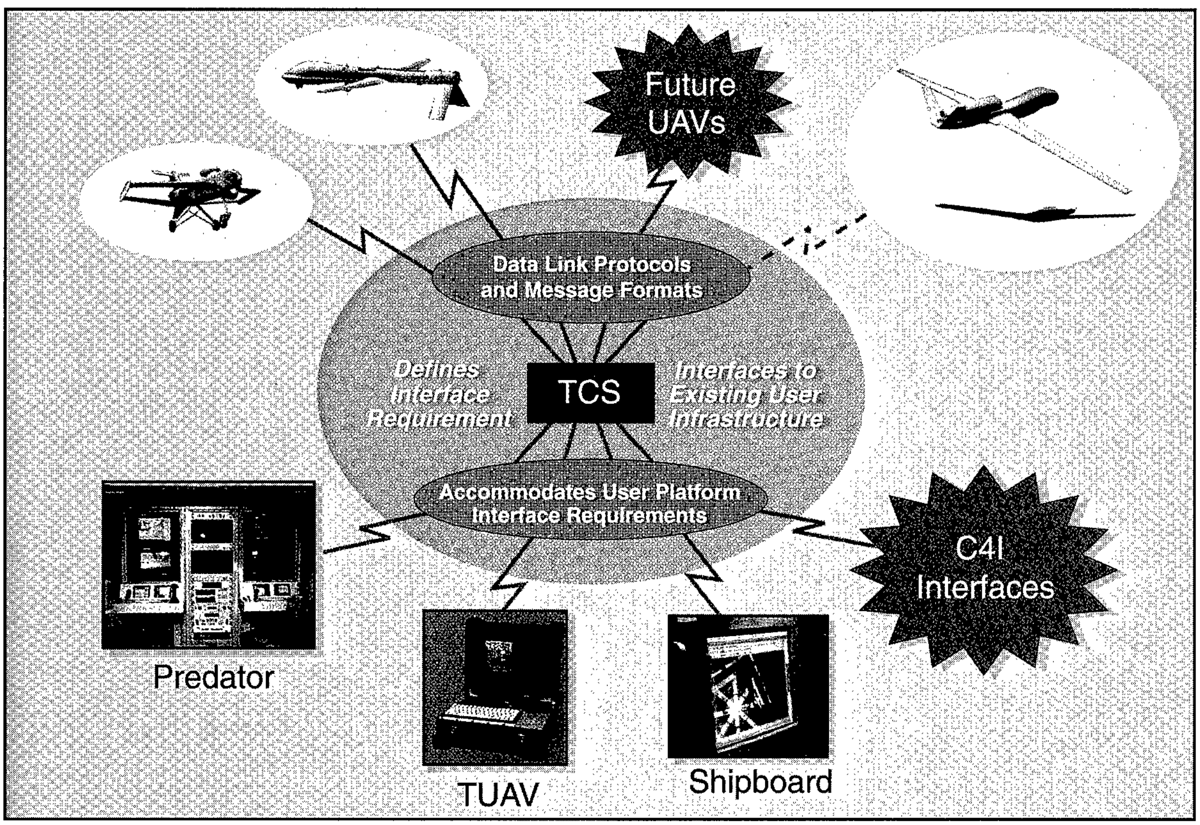
- UAV support to the tactical commander requires a GCS with a relatively small logistics footprint and open systems design to meet joint tactical needs.
- By comparison, the long-dwell and relatively autonomous HAE UAV requires a GCS with high data rates, multi-payload functionality, and the capability to handle significantly more complex missions.

The concept for two GCSs came from the DARO-initiated Common Ground Station Interoperability Working Group (CGSI WG) that addressed the possibility of developing a single GCS for all UAVs. The WG determined there were numerous risks in the single-GCS approach and that it was not an optimal solution.

At the same time, lessons learned from Bosnia clearly illustrate the value of interoperable GCSs and the ability to receive timely information. Field commanders request this capability be enhanced by the addition of video downlinks and the ability of commanders to influence UAV operations in real-time. DARO is pursuing advanced development in tactical data links, open systems architectures, and common modular GCS components.

Tactical Control System

On 21 December 1995, the Department initiated development of the TCS to provide warfighters with a scalable command, control, communications and data dissemination system for tactical UAVs. This program supports the JROC's recommendation for "...development of a common ground reception, processing and control system to ensure full interoperability with other UAVs and collection systems."[1]



[1] JROCM 131-95, 26 October 1995

The TCS Will Assure Interoperability

The TCS program will be developed in two phases:

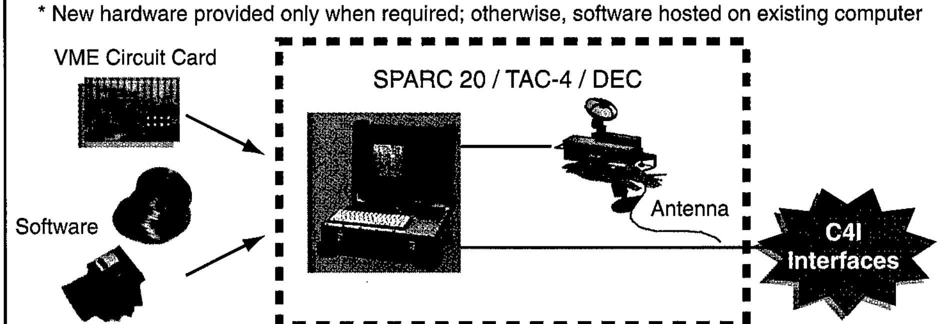
- Phase I (24 months) is an incremental build that demonstrates increasing TCS functionality from passive receipt of data to payload control to multi-UAV control. This phase focuses on demonstrations to generate early user input and evaluation.
- Phase II (duration TBD) will continue demonstrations and system integration, and also include low-rate initial production.

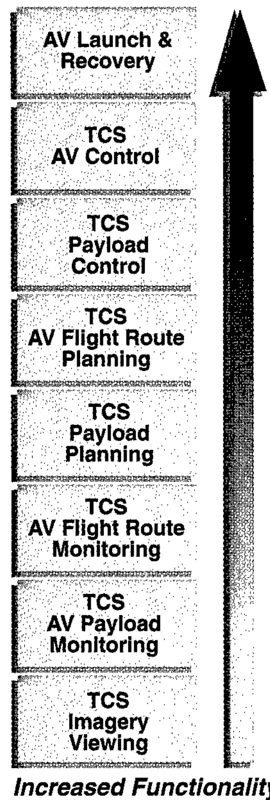
The TCS will provide a migration path to interoperable UAV employment by operators and a common interface to joint and Service C4I systems. It will also establish an interoperability standard for operations and data dissemination for both current and future UAV systems.

The key characteristics of the TCS will involve scalable functionality and flexible capabilities that may be adapted to the characteristics of the user systems. Specific functionality implemented will be in accordance with user doctrine. These concepts are illustrated below.

TCS	Army / Marines	Navy	Air Force
Hardware*	SPARC 20s	TAC-4s	SGI / DECs
Software	Common Core AV-Unique Payload-Unique	Same	Same
Data Links	LOS/SATCOM Analog/Digital	Same	Same
C4I Interfaces	ADOCS AFATDS ASAS IAS Joint STARS / GSM / CGS JDISS (JAWS) MIES ETRAC	JSIPS-N / PTW JMCIS JDISS CCTV TAMPS	CIS CARS JSIPS JDISS

* New hardware provided only when required; otherwise, software hosted on existing computer





ADOCS	Advanced Deep Operations Center System	AFATDS	Advanced Field Artillery Target Data System
ASAS	All-Source Analysis System	CARS	Contingency Airborne Reconnaissance System
CCTV	Closed Circuit Television	CGS	Common Ground Station
CIS	Combat Intelligence System	ETRAC	Enhanced Tactical Radar Correlator
GSM	Ground Station Module	IAS	Intelligence and Analysis System
JAWS	JDISS Army Work Station	JDISS	Joint Deployable Intelligence Support System
JMCIS	Joint Maritime Command Information System	JSIPS	Joint Service Imagery Processing System
JSIPS-N	Joint Service Imagery Processing System-Navy	MIES	Modernized Imagery Exploitation System
PTW	Precision Targeting Workstation	TAMPS	Tactical Aircraft Mission Planning System

Ground Station Programs (Cont'd)

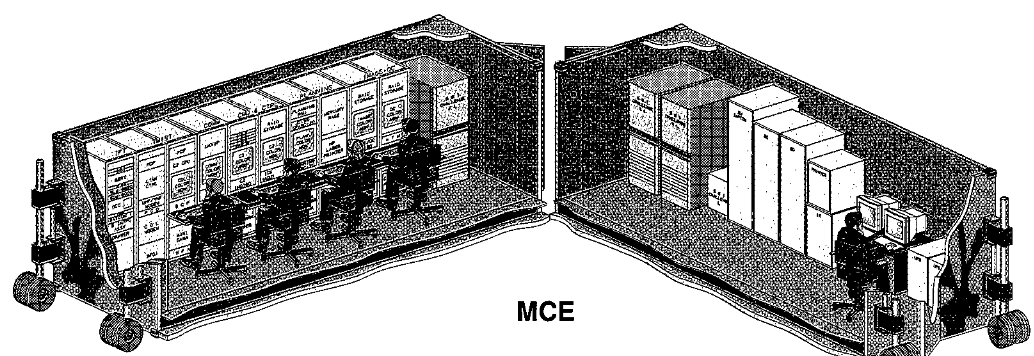
HAE Common Ground Segment

The third component of the three-part HAE UAV system is its Common Ground Segment (CGS). The CGS includes a Launch and Recovery Element (LRE), a Mission Control Element (MCE), associated communications, and a support segment of spares, maintenance and support elements. The LRE prepares, launches and recovers the AV. The MCE plans and executes the mission, dynamically re-tasks the AV (including its sensors), and processes and stores/disseminates imaging and ground MTI data. The MCE and LRE will work with both HAE UAV types; these interfaces will be verified during the ACTD's Phase II. All elements will be available for Phase III exercises, demonstrations (which will also show interoperability with current and planned C4I architectures), and possible contingency deployments.

The HAE CGS will be able to control up to three HAE UAVs at a time by LOS data link and SATCOM relay, thus enabling a single system to maintain a continuous presence for extended days and ranges. The AVs will transmit digital imagery to the MCE via wideband LOS or satellite links for initial processing and relay to theater/CONUS imagery exploitation systems (IESs) using standard (CIGSS-compliant) formats. Selected reports and imagery frames will be broadcast directly to warfighters. When linked with systems such as the Joint Deployable Intelligence Support System (JDISS) and the Global Command and Control System (GCCS), unexploited digital imagery can be transferred in near-real-time to the operational commander for immediate use. Thus, the HAE CGS will provide digital, high-quality, near-real-time imagery to warfighters and users at various command levels.

Although the HAE CGS has no fixed design price, a $20M price goal has been established and substantial use of off-the-shelf software and hardware is planned.

Funding ($M):	FY96	FY97
RDT&E (Defense-wide)	50.2	71.6

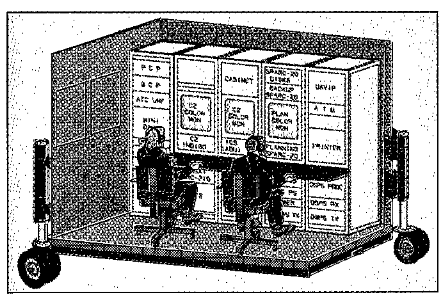


MCE

Plus Power, Cooling, Communications and Support Equipment

CDL Common Data Link
CGS Common Ground Segment
ECU Environmental Control Unit
Gen Generator
HAE High Altitude Endurance
LRE Launch & Recovery Element
MCE Mission Control Element
MIST Modular Interface Surface Terminal
TFT Tactical Field Terminal

HAE CGS	MCE	LRE
Shelter: *Volume*	*3,072 ft³*	*694 ft³*
Weight	36,000 lb	13,000 lb
Shelter Payload – Racks, Equipment, Cables, Operators	7,111	2,634
ECU	10,200	2,000
Gen	10,000	3,000
CDL/MIST	6,500	
Ku-band TFT	13,950	
Airlift Weight	83,761 lb	20,634 lb



LRE

HAE Common Ground Segment (CGS) Concept

C4I and Airspace Interfaces

Common Imagery Ground/Surface System

The Common Imagery Ground/Surface System (CIGSS) is a joint DARO-National Imagery and Mapping Agency (NIMA) program to define and ensure interoperability among imagery systems. It involves an open system approach (based on commercial standards and military adaptations thereof) to provide functional and performance envelopes to guide imagery system design and component selection. Just as it will for manned reconnaissance exploitation systems, CIGSS will enable UAV ground (or airborne) imagery processing and exploitation components to conform or migrate to a common image file format, via common physical and data link standards, common media inputs and outputs, and an interoperable imagery architecture by FY 1998, and thereby meet joint requirements.

Our UAVs will be CIGSS-compliant through their ground control systems and data links. The TCS will be the interface for tactical UAVs, and the HAE CGS for the HAE UAVs; the data link for CIGSS compliance and wider imagery dissemination will be the Common Data Link (CDL), which is also needed to transmit SAR and other payload products, such as nuclear-biological-chemical (NBC) sensor data.

Specific UAV-CIGSS compliance plans are currently as follows:

- **TUAV**: Addition of a tactical (i.e., small/limited) CDL terminal is an *Outrider* P3I program. The first TUAV objective is the dissemination of imagery to tactical commanders, after which wider distribution will be pursued. Meanwhile, a Joint Operational Requirements Document (JORD) is in draft to include CDL in the TCS.
- **HAE UAVs**: *DarkStar's* EO and SAR are planned to be CIGSS-compliant during FY 1997, and *Global Hawk's* EO and SAR during FY 1998, with the HAE CGS as their interface. The CGS is expected to incorporate the Common Imagery Processor (CIP) when available, which will process *DarkStar's* EO and SAR imagery, with growth to process *Global Hawk's* EO, IR and SAR imagery.
- ***Predator:*** Addition of a tactical CDL terminal is currently a P3I program; meanwhile, TCS and HAE CGS upgrades will enable its EO/IR and SAR dissemination after CDL is aboard.
- **Interim UAVs**: *Pioneer* and *Hunter* will comply with CIGSS standards via their ground control stations, as feasible.

Thus, both the tactical and endurance UAV systems planned as major components of the Objective Architecture of 2010 should be CIGSS-compliant within the next few years.

Joint Airborne SIGINT Architecture

Similar activities are underway to achieve an open, interoperable joint airborne SIGINT architecture (JASA), with compliant payload and processing equipment. During the past year, the systems approach to implementing SIGINT on airborne reconnaissance platforms has yielded to a more flexible approach emphasizing modularity. Thus, the former Joint Airborne SIGINT System (JASS) has been renamed Joint SIGINT Avionics Family (JSAF). As SIGINT payloads are actively developed for UAVs, they will be made JASA-compliant.

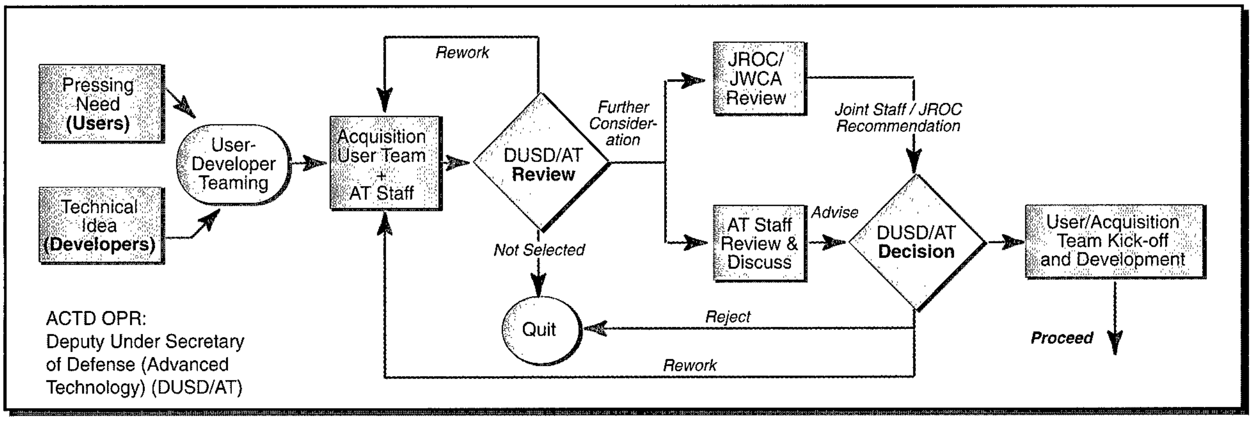
Controlled Airspace Coordination

For the past five years, the Federal Aviation Administration (FAA) has been developing advisory circulars to address airworthiness, maintenance, operator and operating criteria for civil remotely piloted aircraft (RPAs) flying in the National Airspace System (NAS). These circulars are consistent with the way the DoD has been operating its military UAVs (e.g., at the Joint UAV Training Center at Ft Huachuca, AZ, and at the National Training Center at Ft Irwin, CA), and we expect final publication during the next two years. In addition, FAA initiatives with the International Civil Aviation Organization (ICAO) seek to establish regular procedures for RPA/UAV operations in controlled airspace potentially worldwide.

Advanced Concept Technology Demonstrations (ACTDs)

With the exception of *Pioneer* and *Hunter* (as existing systems), all DARP UAV developments are (or have been) ACTDs. *Predator* is the first DoD ACTD to transition to a formal acquisition program, and its lessons-learned are being applied to the DARP's newest system, the TUAV or *Outrider.* The others, *Global Hawk* and *DarkStar* (together with their Common Ground Segment), are complementary air vehicle designs within the HAE UAV ACTD, and have been underway since 1994.

ACTDs are quick-development programs designed to get mature technologies into the hands of users for early evaluation of operational utility; they normally cover two or three years, vs. ten equivalent years for the traditional acquisition program. Further, focus is on their essential capabilities and mission potential; thus, many of their features may need to be revisited, depending on each ACTD's outcome. The ACTD initiation process and ACTD outcome options are as follows:



User Not Prepared to Acquire	User Wants to Acquire	
Options:	**In large numbers:**	**One or a few:**
• Terminate (not cost-effective) • Place "on the shelf" (time not right) • Develop further (good idea; improve implementation)	• Enter acquisition process at the appropriate stage (=*Predator*)	• Fix demonstrator to be operationally suitable, and replicate as required

Predator ACTD Transition

As the first ACTD required in large numbers, *Predator* has been "writing the book" on ACTD issues to be resolved, the reconciliation and phasing of full-acquisition features, and programming of sufficient funds. Four DoD-wide working groups are helping the Transition Integrated Product Team (IPT) resolve three major issues:

- **System numbers**: What is the objective force size and allocation among users?
- **System configuration**: Which capabilities are to be included in the production baseline, as preplanned product improvements (P3I), or as a separate program (see page 19)?
- **Funding**: What is the total system cost, both investment and operations and support (O&S)?

Configuration modifications include:

- Integration of IFF, UHF radio and active de-icing as part of the baseline; and
- A (less mature) heavy fuel engine as part of the P3I program.

The Navy is deciding its course with respect to *Predator* marinization.

Funding is being identified to acquire new systems through FY 2000, to include their necessary development and support items. Total program cost will be identified in the FY 1998 President's Budget.

ACTD Lessons Learned

As a result of the *Predator* and other ACTD experiences, some additional features are being "designed-into" newer ACTDs. For example, the *Predator* ACTD had no projected procurement budget: at its outset (January 1994), nobody knew how well it would perform. Further, while ACTD unit costs may be low (often representing off-the-shelf [OTS], components), militarizing some capabilities and realizing logistics support needs both increase program acquisition costs. For example, while an ACTD *Predator* demo system cost about $15 million, a combat-ready production system (with configuration changes, added payload and link subsystems, and full integrated logistics support [ILS] provisions) requires about twice that sum.

By comparison, the TUAV ACTD includes funding provisions for transition plus significant out-year procurement funds. Eight IPTs are active to assure integrated system development. Thus, rather than committing prematurely to a production program before the ACTD results are known, early planning and an LRIP option will optimize the ACTD-to-formal acquisition transition process if the ACTD is deemed successful.

In parallel, an OSD policy document on Transition of ACTDs to the Acquisition Process has recently been published to guide all ACTDs, if successful. The key challenges to maintaining momentum during the transition period are:

- Formalize military requirements and CONOPS (which drive configuration and numbers)
- Complete any needed testing and documentation (especially if new features are to be added)
- Assure system/force affordability (e.g., as ACTD criteria for the TUAV and HAE UAV production air vehicles)
- Optimize the acquisition strategy
- Program the necessary acquisition funding (as determined by the system's demonstrated utility)
- Identify and program for life-cycle costs.

Future ACTDs

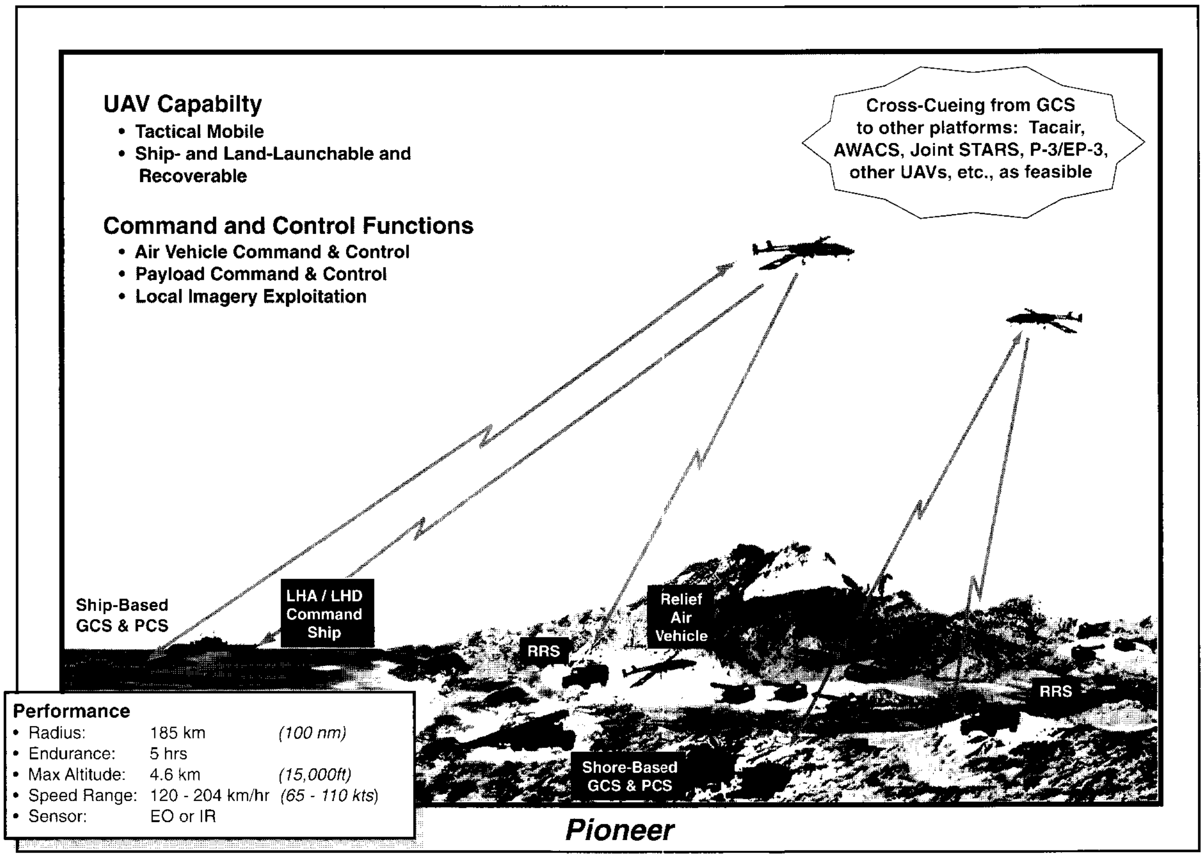
Future-year ACTDs are being defined for high-potential, maturing technologies, many of which will apply to UAVs in the key areas of payload options, information processing, and additional mission applications. The ACTDs initiated during FY 1996 and 1997 that are applicable to UAVs are indicated below.

UAV-Relevant ACTDs

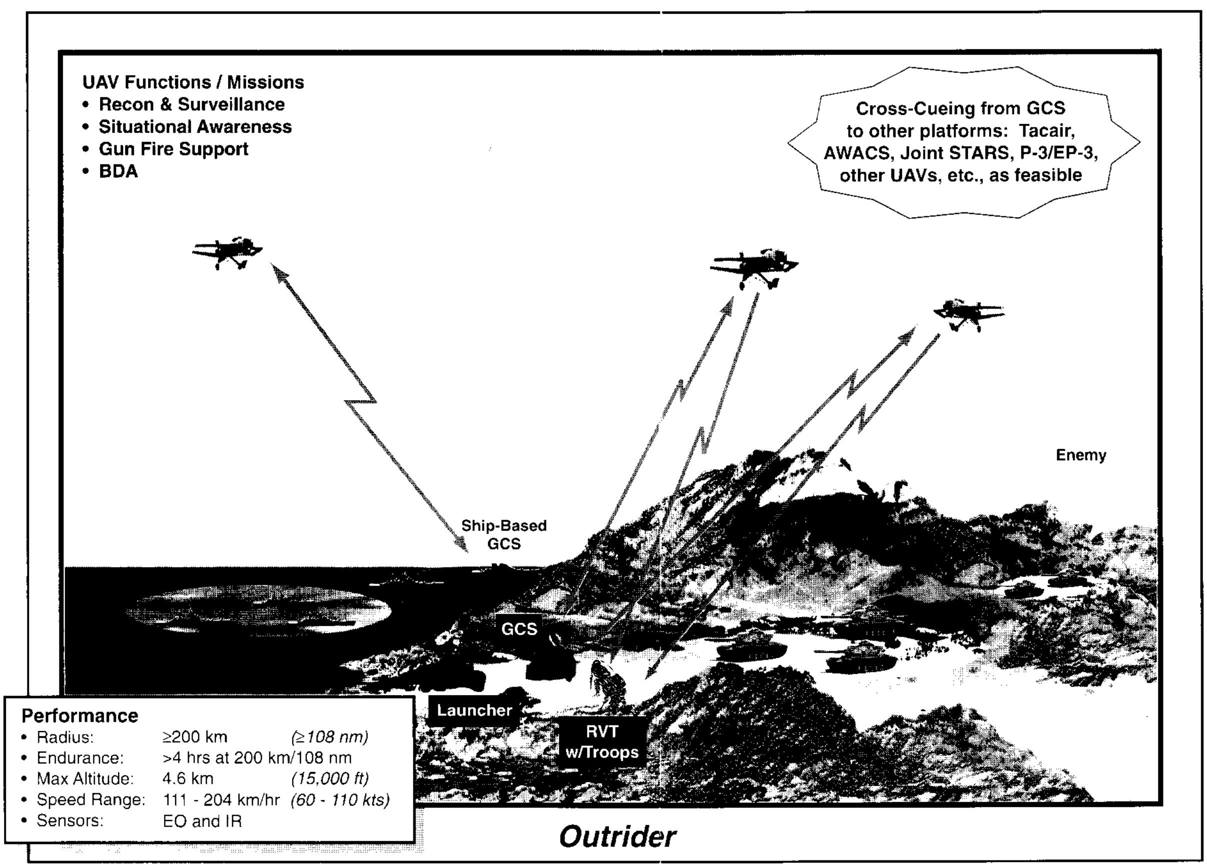
Initiated in FY96	Initiated in FY97
Air Base/Port Biological Warfare Detection	Counter Concealment, Camouflage & Deception (CCD)
Battlefield Awareness and Data Dissemination	Counter-Proliferation II
Combat Identification	Cruise Missile Defense II
Counter-Proliferation	Global Grid Tactical Fiber
Joint Logistics	Integrated Collection Management
Miniature Air-Launched Decoy	Military Operations in Urban Terrain
Semi-Automated IMINT Processing	Rapid Battlefield Visualization
Tactical UAV	Survivable Armed Reconnaissance on the Digital Battlefield
	Unattended Ground-based Sensors (UGSs)
	Wide Area Tracking System

I see ACTDs as creating three opportunities. First, they give us the ability to reduce operational risk early in the acquisition process. Second, they provide us with an approach for compressing acquisition cycle time—the time it takes to develop and field weapon systems. And third, ACTDs are a mechanism for stimulating the innovations needed to implement a revolution in military affairs.

Dr. Paul G. Kaminski, USD(A&T)
Keynote Address at the ACTD Manager's Conference
Defense Systems Management College (DSMC), Ft. Belvoir, VA, 10 September 1996



Pioneer



Outrider

UAV Conce of Operati (CONOPS

Notional CONOPS fo UAV shows:

- **Relationship to th**
- **Operational area and**
- **Communication p to control the UA disseminate infor**

Graphic terrain is based on Digital Terrain Elevation Data (DTED) from Bosnia

Legend:

AWACS	Airborne Warning System
BDA	Battle Damage A
BLOS	Beyond Line of S
C4I	Command, Cont nications. Com Intelligence
CGS	Common Ground
COMSAT	Communications (Commercial)
CONUS	Continental Unite
EO	Electro-Optical
GCS	Ground Control S
GPS	Global Positionin
GSM	Ground Station M
HAE	High Altitude End
IES	Imagery Exploita
IR	Infrared
JBS	Joint Broadcast S
Joint STARS	Joint Surveillance Attack Radar S
LHA/LHD	Landing Helicopt ous / Dock
LOS	Line of Sight
LRE	Launch and Rec
MCE	Mission Control I
PCS	Portable Control
RRS	Remote Receive
RVT	Remote Video Te
SAR	Synthetic Apertu
SATCOM	Satellite Commu
UAV	Unmanned Aeria
UHF	Ultra High Frequ

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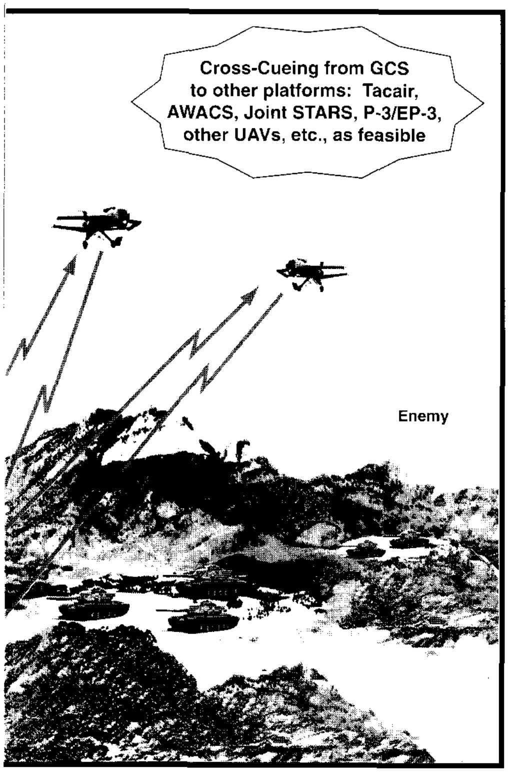

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UAV Concepts of Operation (CONOPS)

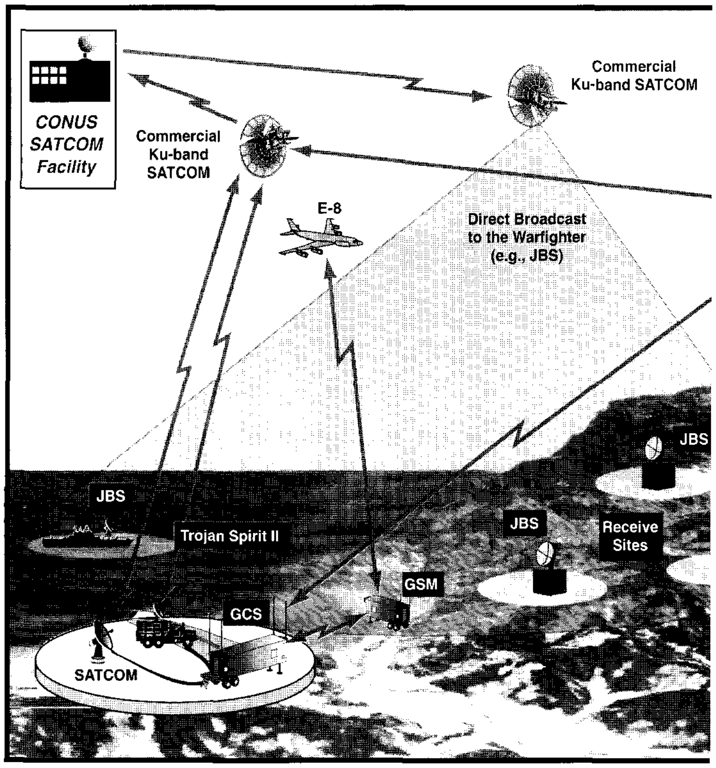
Notional CONOPS for each UAV shows:

- Relationship to the user;
- Operational area covered; and
- Communication paths to control the UAV and disseminate information

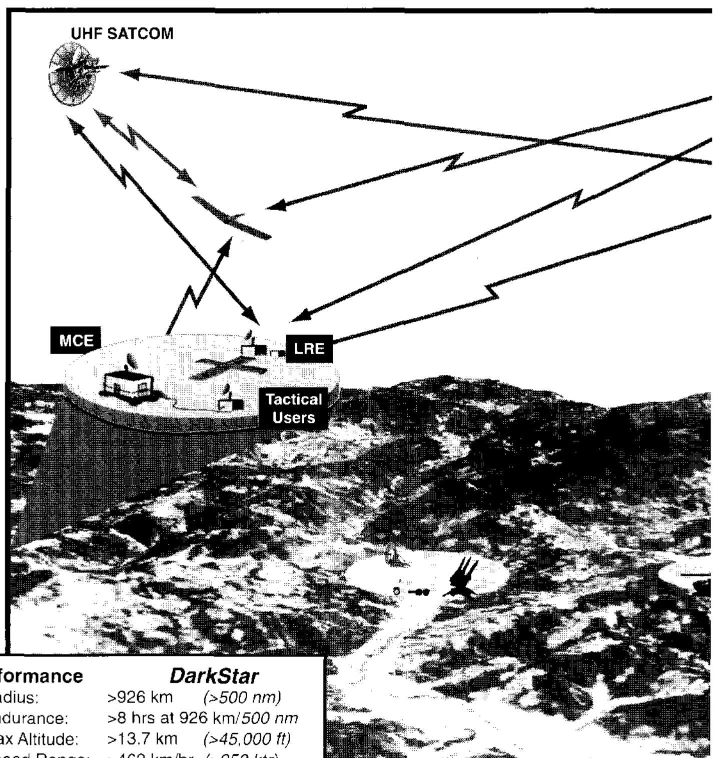
Graphic terrain is based on Digital Terrain Elevation Data (DTED) from Bosnia

Legend:

AWACS	Airborne Warning and Control System
BDA	Battle Damage Assessment
BLOS	Beyond Line of Sight
C4I	Command, Control, Communications, Computers, and Intelligence
CGS	Common Ground Segment
COMSAT	Communications Satellite (Commercial)
CONUS	Continental United States
EO	Electro-Optical
GCS	Ground Control Station
GPS	Global Positioning System
GSM	Ground Station Module
HAE	High Altitude Endurance
IES	Imagery Exploitation Systems
IR	Infrared
JBS	Joint Broadcast System
Joint STARS	Joint Surveillance and Target Attack Radar System
LHA/LHD	Landing Helicopter Amphibious / Dock
LOS	Line of Sight
LRE	Launch and Recovery Element
MCE	Mission Control Element
PCS	Portable Control Station
RRS	Remote Receiver Station
RVT	Remote Video Terminal
SAR	Synthetic Aperture Radar
SATCOM	Satellite Communications
UAV	Unmanned Aerial Vehicle
UHF	Ultra High Frequency



Predator



Performance	*DarkStar*
• Radius:	>926 km (*>500 nm*)
• Endurance:	>8 hrs at 926 km/*500 nm*
• Max Altitude:	>13.7 km (*>45,000 ft*)
• Speed Range:	>463 km/hr (*>250 kts*)
• Sensor:	EO or SAR

HAEs

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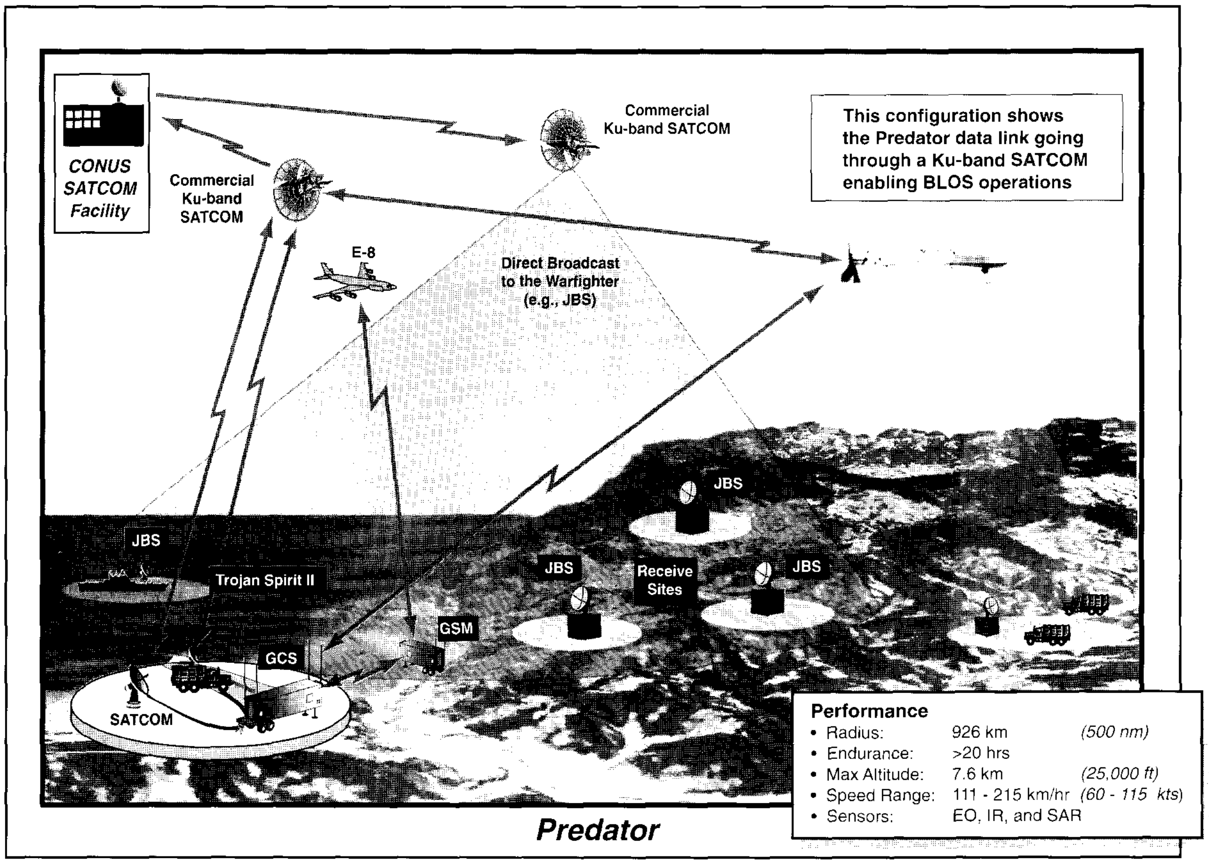

Performance		
• Radius:	926 km	*(500 nm)*
• Endurance:	>20 hrs	
• Max Altitude:	7.6 km	*(25,000 ft)*
• Speed Range:	111 - 215 km/hr	*(60 - 115 kts)*
• Sensors:	EO, IR, and SAR	

Predator

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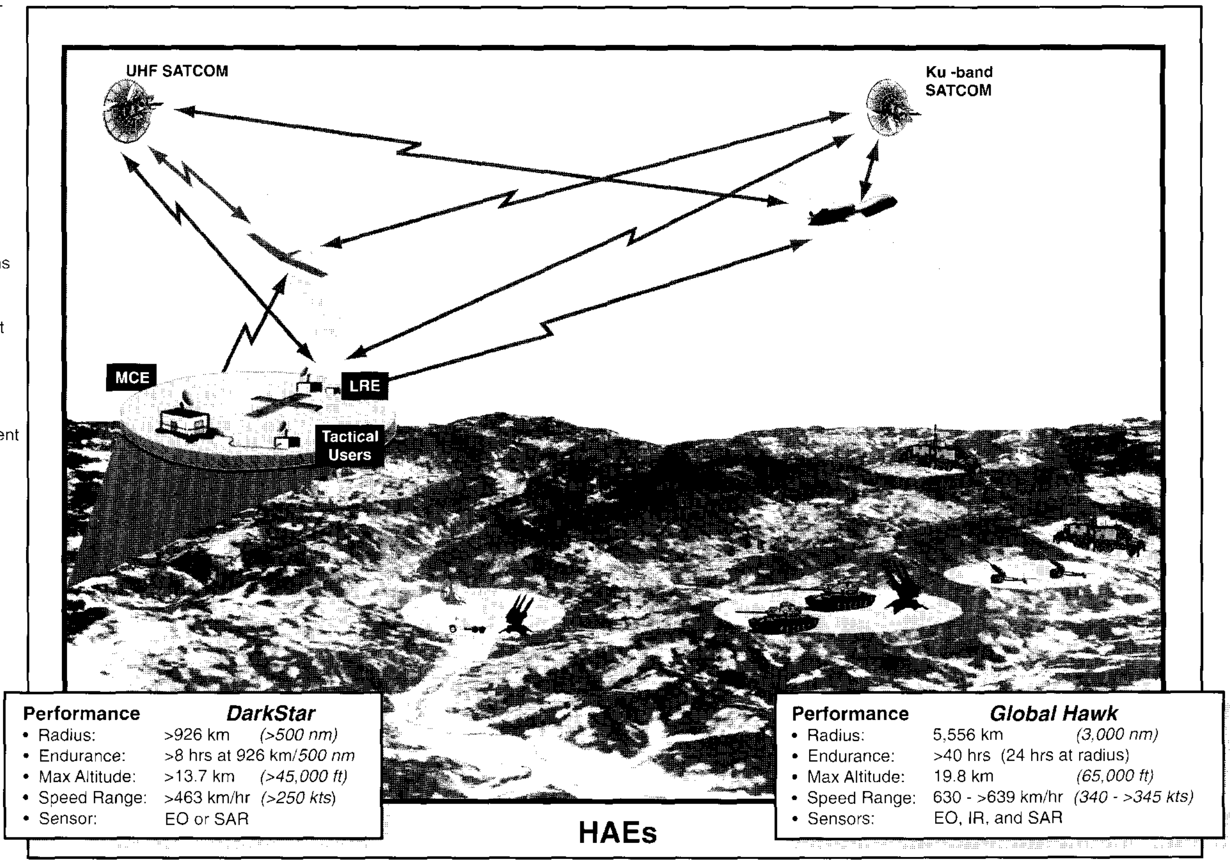

Performance	***DarkStar***	
• Radius:	>926 km	*(>500 nm)*
• Endurance:	>8 hrs at 926 km/*500 nm*	
• Max Altitude:	>13.7 km	*(>45,000 ft)*
• Speed Range:	>463 km/hr	*(>250 kts)*
• Sensor:	EO or SAR	

Performance	***Global Hawk***	
• Radius:	5,556 km	*(3,000 nm)*
• Endurance:	>40 hrs (24 hrs at radius)	
• Max Altitude:	19.8 km	*(65,000 ft)*
• Speed Range:	630 - >639 km/hr	*(340 - >345 kts)*
• Sensors:	EO, IR, and SAR	

HAEs



	CHARACTERISTICS	Pioneer	Hunter	Tactical UAV Outrider
Operational	**ALTITUDE: Maximum** (km, *ft*) **Operating** (km, *ft*)	4.6 km *15,000 ft* ≤4.6 km *≤15,000 ft*	4.6 km *15,000 ft* ≤4.6 km *≤15,000 ft*	4.6 km *15,000 ft* 1.5 km *5,000 ft*
	ENDURANCE (Max): (hrs)	5 hrs	11.6 hrs	>4 hrs (+ reserve) @ 200 km
	RADIUS OF ACTION: (km, *nm*)	185 km *100 nm*	267 km *144 nm*	≥200 km *≥108 nm*
	SPEED: Maximum (km/hr, *kts*) **Cruise** (km/hr, *kts*) **Loiter** (km/hr, *kts*)	204 km/hr *110 kts* 120 km/hr *65 kts* 120 km/hr *65 kts*	196 km/hr *106 kts* >165 km/hr *>89 kts* <165 km/hr *<89 kts*	204 km/hr *110 kts* 167 km/hr *90 kts* 111-139 km/hr *60-75 kts*
	CLIMB RATE (Max): (m/min, *fpm*)	[N/A] [N/A]	232 m/min *761 fpm*	488 m/min *1,600 fpm*
	DEPLOYMENT NEEDS:* *Depends on equipage & duration	Multiple* C-130, C-141, C-17 or C-5 sorties Ship: LPD	Multiple* C-130 sorties	Single C-130 (drive on/drive off) Ship: LHA/LHD (roll on/roll off)
Air Vehicle	**PROPULSION: Engine(s)** **– Maker** **– Rating** **– Fuel** **– Capacity** (L, *gal*)	One Recip; 2 cylinders, 2-stroke – Sachs & Fichtel SF 2-350 19.4 kw *26 hp* AVGAS (100 octane) 42/44.6 L *11/12 gal*	Two Recips: 4-stroke – Moto Guzzi (Props: 1 pusher/1 puller) 44.7 kw *60 hp* MOGAS (87 octane) 189 L *50 gal*	One Recip; pusher prop – McCulloch 4318F Short Block/Diesel 37.3 kw *50 hp* Heavy Fuel (JP-8) 48 L *12.7 gal*
	WEIGHT: Empty (kg, *lb*) **Fuel Weight** (kg, *lb*) **Payload** (kg, *lb*) **Max Takeoff** (kg, *lb*)	125/138 kg *276/304 lb* 30/ 32 kg *66/ 70 lb* 34/ 34 kg *75/ 75 lb* 195/205 kg *430/ 452 lb*	544 kg *1,200 lb* 136 kg *300 lb* 91 kg *200 lb* 726 kg *1,600 lb*	136 kg *300 lb* 39 kg *85 lb* 27 kg *60 lb* >227 kg *>500 lb*
	DIMENSIONS: Wingspan (m, *ft*) **Length** (m, *ft*) **Height** (m, *ft*)	5.2 m *17.0 ft* 4.3 m *14.0 ft* 1.0 m *3.3 ft*	8.9 m *29.2 ft* 7.0 m *23.0 ft* 1.7 m *5.4 ft*	3.4 m *11.0 ft* 3.0 m *9.9 ft* 1.5 m *5.0 ft*
	AVIONICS: Transponder **Navigation**	Mode IIIC IFF GPS	Mode IIIC IFF GPS	Mode IIIC IFF GPS and INS
	LAUNCH & RECOVERY:	Land: RATO, Rail; Runway, (A-Gear) Ship: RATO; Deck w/Net	RATO, Unimproved Runway (200 m)	75m x 30m x 10m "box" (dependent on weight and altitude)
	GUIDANCE & CONTROL:	Remote Control/Preprogrammed	Remote Control/Preprogrammed	Prepgmd/Remote Con/Autopilot & -lan
Payload & Links	**SENSOR(S):**	EO or IR	EO and IR	EO and IR (SAR growth)
	DATA LINK(S): Type	Uplink: C-band/LOS & UHF Downlink: C-band/LOS	C-band/LOS	C-band/LOS (Digital growth)
	Bandwidth: (Hz)	C-band/LOS: 10 Mhz UHF: 600 MHz	20 MHz	4.4–5.0/5.25–5.85 GHz
	Data Rate: (bps)	C-band/LOS & UHF: 7.317 kbps	7.317 kbps	Full Duplex: 9,600 baud
	C2 LINK(S):	Through Data Link	Through Data Link	Through Data Link
System & Support	**SYSTEM COMPOSITION:**	5 AVs, 9 payloads (5 day cameras, 4 FLIRs), 1 GCS, 1 PCS, 1–4 RRSs, 1 TML (USMC units only)	8 AVs, 8 MOSPs, 4 ADRs, 4 RVTs, 3 GCSs/MPSs, 2 GDTs, 1 LRS, 1 MMF	4 AVs, 2 GCSs, 2 GDTs, 1 RVT, 4 MMPs, LRE, GSE
	PRIME/KEY CONTRACTOR(S):	Pioneer UAV, Inc.	TRW Avionics & Surveillance Group	Alliant Techsystems
	MAJOR SUBCONTRACTORS: – Air Vehicle, Propulsion, Avionics, Payloads, Information Processing, Communications, Ground and Support Systems	AAI Corp; Computer Instrument Corp; General Svcs Engrg; Humphrey; Israel Aircraft Industries (IAI); Sachs; Trimble Navigation	Alaska Ind.; Burtek; Consolidated Ind.; Fiber Com; Gichner; IAI/Malat; IAI/Elta; IAI/Malat/Tamam; ITT/Cannon; Lopardo: Mechtronics; Moto Guzzi	Bendix King; BMS; Cirrus Design; CDL FLIR Systems; GS Engineering; IAI Tamam; IntegriNautics; Lockheed Mart Mission Technologies; Phototelesis-TI; Rockwell International; SwRI; Stratos Group; Teftec Inc.
	Column Notes:	*AV weights: Option 2 / Option 2+*		*Developmental estimates*

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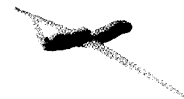


er	Tactical UAV **Outrider**	Tier II, MAE UAV **Predator**	Tier II+, CONV HAE UAV **Global Hawk**	Tier III–, LO HAE UAV **DarkStar**
)0 ft)0 ft	4.6 km *15,000 ft* 1.5 km *5,000 ft*	7.6 km *25,000 ft* 4.6 km *15,000 ft*	19.8 km *65,000 ft* 15.2–19.8 km *50,000–65,000 ft*	>13.7 km *>45,000 ft* >13.7 km *>45,000 ft*
	>4 hrs (+ reserve) @ 200 km	>20 hrs	>40 hrs (24 hrs at 5,556 km/*3,000 nm*)	>8 hrs (at 926 km/*500 nm*)
nm	≥200 km *≥108 nm*	926 km *500 nm*	5,556 km *3,000 nm*	>926 km *>500 nm*
kts kts kts	204 km/hr *110 kts* 167 km/hr *90 kts* 111-139 km/hr *60-75 kts*	204-215 km/hr *110-115 kts* 120-130 km/hr *65- 70 kts* 111-120 km/hr *60- 65 kts*	>639 km/hr *>345 kts* 639 km/hr *345 kts* 630 km/hr *340 kts*	>463 km/hr *>250 kts* >463 km/hr *>250 kts* >463 km/hr *>250 kts*
fpm	488 m/min *1,600 fpm*	168 m/min *550 fpm*	1,036 m/min *3,400 fpm*	610 m/min *2,000 fpm*
	Single C-130 (drive on/drive off) Ship: LHA/LHD (roll on/roll off)	Multiple* C-130 sorties	AV: Self-Deployable GS: Multiple* C-141, C-17 or C-5 sorties	Multiple* C-141, C-17 or C-5 sorties
pusher/1 puller)) hp	One Recip; pusher prop – McCulloch 4318F Short Block/Diesel 37.3 kw *50 hp*	One Fuel-Injected Recip; 4-stroke – Rotax 912/Rotax 914 63.4/75.8 kw *85/105 hp*	One Turbofan – Allison AE3007H 32 kN *7,050 lb static thrust*	One Turbofan -- Williams FJ 44-1A 8.45 kN *1,900 lb static thrust*
gal	Heavy Fuel (JP-8) 48 L *12.7 gal*	AVGAS (100 Octane) 409 L *108 gal*	Heavy Fuel (JP-8) 8,176 L *2,160 gal*	Heavy Fuel (JP-8) 1,575 L *416 gal*
0 lb 0 lb 0 lb 0 lb	136 kg *300 lb* 39 kg *85 lb* 27 kg *60 lb* >227 kg *>500 lb*	544 kg *1,200 lb* 295 kg *650 lb* 204 kg *450 lb* 1,043 kg *2,300 lb*	4,055 kg *8,940 lb* 6,668 kg *14,700 lb* 889 kg *1,960 lb* 11,612 kg *25,600 lb*	1,978 kg *4,360 lb* 1,470 kg *3,240 lb* 454 kg *1,000 lb* 3,901 kg *8,600 lb*
.2 ft .0 ft .4 ft	3.4 m *11.0 ft* 3.0 m *9.9 ft* 1.5 m *5.0 ft*	14.8 m *48.7 ft* 8.1 m *26.7 ft* 2.2 m *7.3 ft*	35.4 m *116.2 ft* 13.5 m *44.4 ft* 4.6 m *15.2 ft*	21.0 m *69 ft* 4.6 m *15 ft* 1.5 m *5 ft*
	Mode IIIC IFF GPS and INS	Mode IIIC IFF GPS and INS	Mode I / II / IIIC / IV IFF GPS and INS	Mode IIIC IFF GPS and INS
ınway (200 m)	75m x 30m x 10m "box" (dependent on weight and altitude)	Runway (760 m/*2,500 ft*)	Runway (1,524 m/*5,000 ft*)	Runway (<1,219 m/*<4,000 ft*)
ɔgrammed	Prepgmd/Remote Con/Autopilot & -land	Prepgmd/Remote Control/Autonomous	Preprogrammed/Autonomous	Preprogrammed/Autonomous
	EO and IR (SAR growth)	EO, IR, and SAR	EO, IR, and SAR	EO or SAR
	C-band/LOS (Digital growth)	C-band/LOS; UHF/MILSATCOM; Ku-band/SATCOM	Ku-band/SATCOM; X-Band CDL/LOS	Ku-band/SATCOM; X-Band CDL/LOS
	4.4–5.0/5.25–5.85 GHz	C-band/LOS: 20 MHz UHF/MILSATCOM: 25 kHz Ku-band/SATCOM: 5 MHz	UHF/SATCOM: 25 kHz Ku-band/SATCOM: 2.2-72 MHz X-band CDL/LOS: 10-120 MHz	UHF/SATCOM: 25 kHz Ku-band/SATCOM: 2.2 MHz X-band CDL/LOS: 10-60 MHz
	Full Duplex: 9,600 baud	C-band/LOS: 20 MHz Analog UHF/MILSATCOM: 4.8 kbps Ku-band/ SATCOM: 1.544 Mbps	UHF/SATCOM: 19.2 kbps Ku-band/SATCOM: 1.5-50 Mbps X-band CDL/LOS: 274 Mbps	UHF/SATCOM: 19.2 kbps Ku-band/SATCOM: 1.5 Mbps X-band CDL/LOS: 137 Mbps
	Through Data Link	UHF/MILSATCOM	UHF MILSATCOM: Ku-band/SATCOM; UHF/LOS; X-band CDL/LOS	UHF MILSATCOM: Ku-band/SATCOM; UHF/LOS; X-band CDL/LOS
Rs, 4 RVTs, s, 1 LRS, 1 MMF	4 AVs, 2 GCSs, 2 GDTs, 1 RVT, 4 MMPs, LRE, GSE	4 AVs, 1 GCS, 1 Trojan Spirit II Dissemination System, GSE	AVs (TBD); HAE CGS	AVs (TBD); HAE CGS
illance Group	Alliant Techsystems	General Atomics-Aeronautical Systems	Teledyne Ryan Aeronautical	Lockheed Martin Skunk Works/ Boeing Military Aircraft Division
ɔnsolidated Ind.; I/Malat; IAI/Elta; Cannon; Moto Guzzi	Bendix King; BMS; Cirrus Design; CDL; FLIR Systems; GS Engineering; IAI Tamam; IntegriNautics; Lockheed Martin; Mission Technologies; Phototelesis-TI; Rockwell International; SwRI; Stratos Group; Teftec Inc.	Boeing Defense & Space; Litton; LMTCS (Ku-band SATCOM); Magnavox/ Carlyle Gp; Northrop Grumman (SAR); Rotax Cp; Versatron Cp	Allison Engine/Rolls Royce; Raytheon E-Systems; GDE Systems/Tracor; Héroux; Hughes Aircraft; Lockheed Martin Wideband Systems; Rockwell International; Aurora Flight Sciences	ABS Cp; Advanced Composites; Aydin Vector; CI Fiberite; Hexcel; Honeywell Avionics; Litton G&C; Lockheed Martin Wideband Systems; Recon/Optical; Rockwell Collins; Rosemount Aerospace; Northrop Grumman; Williams Internationa

Developmental estimates (Outrider)

Developmental estimates (Global Hawk)

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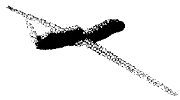



: UAV *or*	Tier II+, CONV HAE UAV ***Global Hawk***	Tier III–, LO HAE UAV ***DarkStar***
00 ft	19.8 km *65,000 ft*	>13.7 km *>45,000 ft*
00 ft	15.2–19.8 km *50,000–65,000 ft*	>13.7 km *>45,000 ft*
	>40 hrs (24 hrs at 5,556 km/*3,000 nm*)	>8 hrs (at 926 km/*500 nm*)
nm	5,556 km *3,000 nm*	>926 km *>500 nm*
5 kts	>639 km/hr *>345 kts*	>463 km/hr *>250 kts*
) kts	639 km/hr *345 kts*	>463 km/hr *>250 kts*
5 kts	630 km/hr *340 kts*	>463 km/hr *>250 kts*
fpm	1,036 m/min *3,400 fpm*	610 m/min *2,000 fpm*
	AV: Self-Deployable GS: Multiple* C-141, C-17 or C-5 sorties	Multiple* C-141, C-17 or C-5 sorties
; 4-stroke	One Turbofan – Allison AE3007H	One Turbofan -- Williams FJ 44-1A
05 hp	32 kN *7,050 lb static thrust*	8.45 kN *1,900 lb static thrust*
	Heavy Fuel (JP-8)	Heavy Fuel (JP-8)
3 gal	8,176 L *2,160 gal*	1,575 L *416 gal*
)0 lb	4,055 kg *8,940 lb*	1,978 kg *4,360 lb*
50 lb	6,668 kg *14,700 lb*	1,470 kg *3,240 lb*
50 lb	889 kg *1,960 lb*	454 kg *1,000 lb*
)0 lb	11,612 kg *25,600 lb*	3,901 kg *8,600 lb*
3.7 ft	35.4 m *116.2 ft*	21.0 m *69 ft*
3.7 ft	13.5 m *44.4 ft*	4.6 m *15 ft*
7.3 ft	4.6 m *15.2 ft*	1.5 m *5 ft*
	Mode I / II / IIIC / IV IFF GPS and INS	Mode IIIC IFF GPS and INS
)	Runway (1,524 m/*5,000 ft*)	Runway (<1,219 m/<*4,000 ft*)
ol/Autonomous	Preprogrammed/Autonomous	Preprogrammed/Autonomous
	EO, IR, and SAR	EO or SAR
ATCOM;	Ku-band/SATCOM; X-Band CDL/LOS	Ku-band/SATCOM; X-Band CDL/LOS
 Hz Hz	UHF/SATCOM: 25 kHz Ku-band/SATCOM: 2.2-72 MHz X-band CDL/LOS: 10-120 MHz	UHF/SATCOM: 25 kHz Ku-band/SATCOM: 2.2 MHz X-band CDL/LOS: 10-60 MHz
nalog kbps 44 Mbps	UHF/SATCOM: 19.2 kbps Ku-band/SATCOM: 1.5-50 Mbps X-band CDL/LOS: 274 Mbps	UHF/SATCOM: 19.2 kbps Ku-band/SATCOM: 1.5 Mbps X-band CDL/LOS: 137 Mbps
	UHF MILSATCOM: Ku-band/SATCOM; UHF/LOS; X-band CDL/LOS	UHF MILSATCOM: Ku-band/SATCOM; UHF/LOS; X-band CDL/LOS
Spirit II GSE	AVs (TBD); HAE CGS	AVs (TBD); HAE CGS
autical Systems	Teledyne Ryan Aeronautical	Lockheed Martin Skunk Works/ Boeing Military Aircraft Division
e; Litton; OM); Magnavox/ umman (SAR);	Allison Engine/Rolls Royce; Raytheon E-Systems; GDE Systems/Tracor; Héroux; Hughes Aircraft; Lockheed Martin Wideband Systems; Rockwell International; Aurora Flight Sciences	ABS Cp; Advanced Composites; Aydin Vector; CI Fiberite; Hexcel; Honeywell Avionics; Litton G&C; Lockheed Martin Wideband Systems; Recon/Optical; Rockwell Collins; Rosemount Aerospace; Northrop Grumman; Williams International

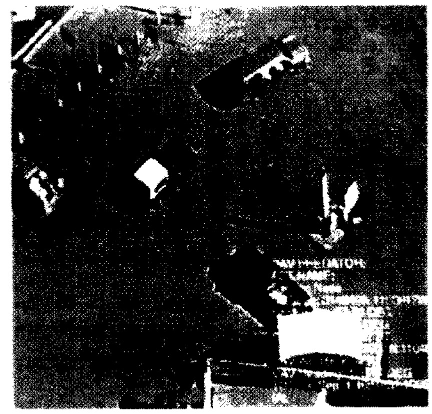
Developmental estimates

Legend:

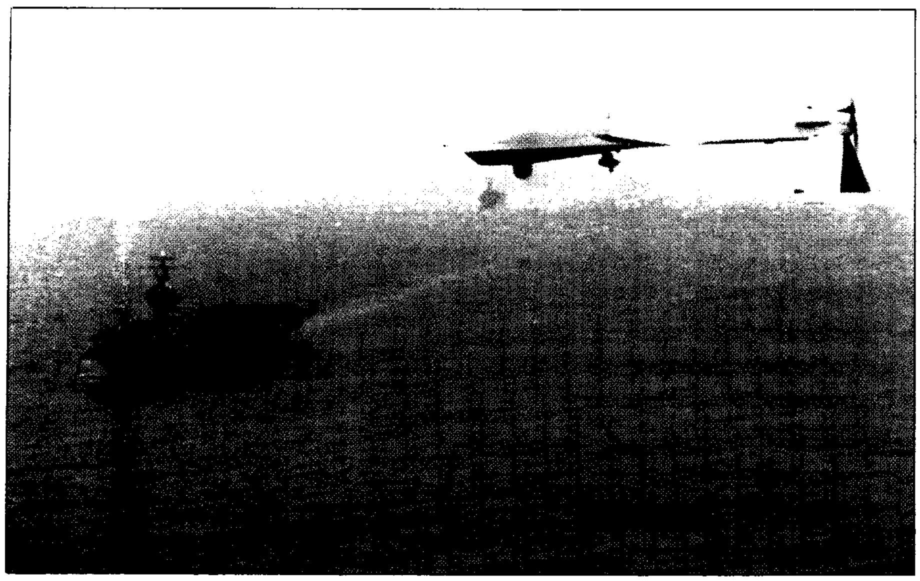
ADR	Air Data Relay
A-Gear	Arresting Gear
AV	Air Vehicle
AVGAS	Aviation Gasoline
CDL	Common Data Link
CGS	Common Ground Segment
EO	Electro-Optical
FLIR	Forward-Looking Infrared
GCS	Ground Control Station
GDT	Ground Data Terminal
GPS	Global Positioning System
GSE	Ground Support Equipment
HAE	High Altitude Endurance
IFF	Identification Friend or Foe
INS	Inertial Navigation System
IR	Infrared
JP	Jet Petroleum
kHz	Kilohertz
LHA	Landing Helicopter Amphibious
LHD	Landing Helicopter Dock
LOS	Line of Sight
LPD	Landing Platform Dock
LRE	Launch & Recovery Equipment
LRS	Launch & Recovery System
MAE	Medium Altitude Endurance
MHz	Megahertz
MMF	Mobile Maintenance Facility
MMP	Modular Mission Payload
MOGAS	Mobility Gasoline
MOSP	Multi-mission Optronic Stabilized Payload
MPS	Mission Planning Station
PCS	Portable Control Station
RATO	Rocket-Assisted Takeoff
RRS	Remote Receiving Station
RVT	Remote Video Terminal
SATCOM	Satellite Communications (Military)
TML	Truck-Mounted Launcher
UHF	Ultra High Frequency

3

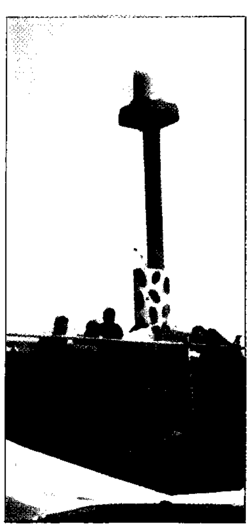
U.S. Customs Service P-3 AEW and *Predator* ground control station (GCS)



Predator imagery of simulated drug transfer



Predator images USS Carl Vinson during COMPTUEX 96-1A



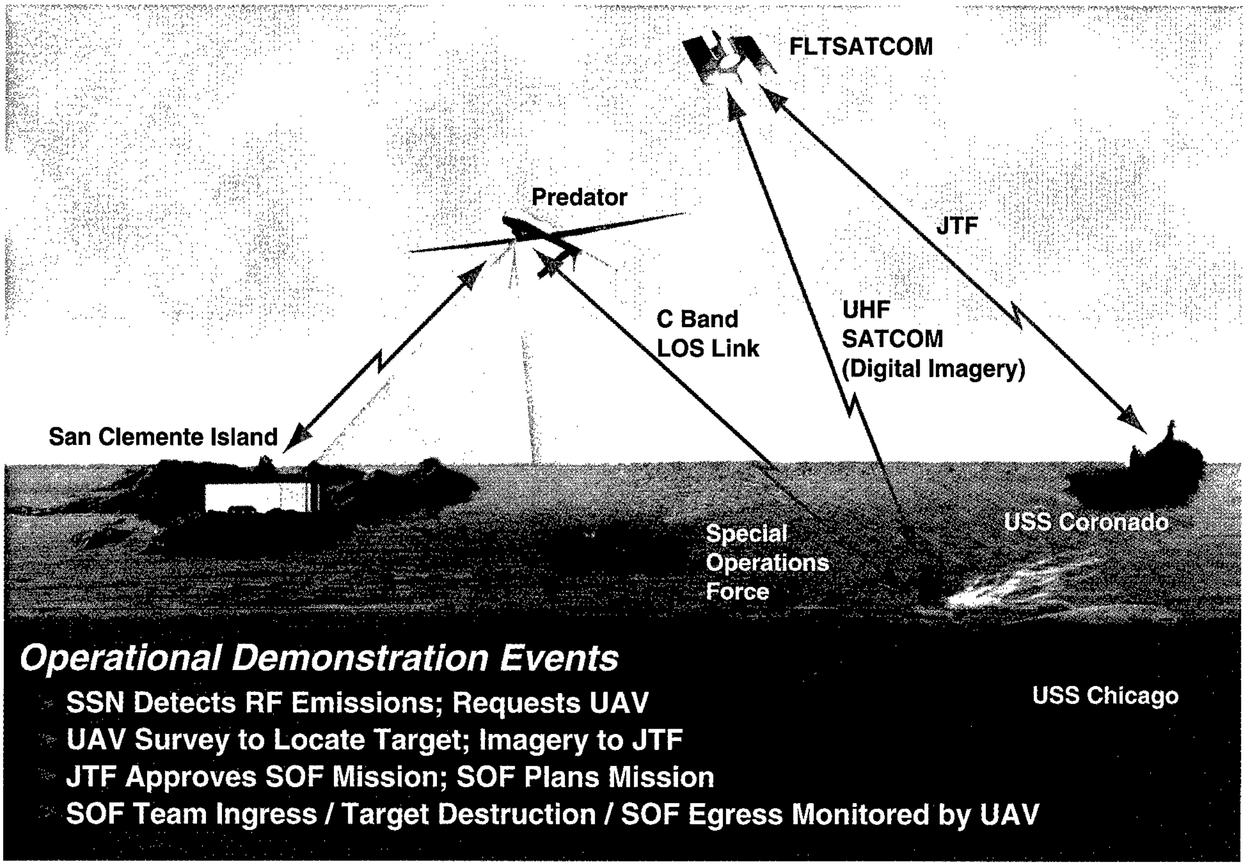
Left: *Predator* system antenna mounted atop USS Chicago's periscope
Center: *Predator* viewed through USS Chicago's periscope
Right: Operating *Predator's* mini-GCS aboard USS Chicago

UAV Demonstrations

FY 1996 UAV demonstrations are summarized below. In all cases, their results reflected the situations that applied at the time for the assets used and concepts explored.

What, Where, When, Why	Goals and Main Features	Findings and Documentation
U.S. Customs Service (USCS) P-3 /UAV Interoperability Demo • Ft Huachuca, AZ, test area • 20 Oct – 2 Nov 95 • Congressional direction to DoD (HR Report 103-747)	Test UAV support of USCS P-3 AEW (using MAE *Predator*) • Acquire/track people and vehicles in representative scenarios • Test/evaluate other UAV applications to USCS work	Worked best in daylight, rural areas Need better all-weather/all-environment ops & sensors, data correlation, and interoperability UAV air traffic control a constraint in unrestricted airspace UAV detectability, costs also limit USCS utility • *Report to Congress, 1 May 96*
Navy Carrier Battle Group (CVBG) Exercise • COMPTUEX 96-1A off the coast of Southern California • 28 Nov – 10 Dec 95 • Part of Maritime Evaluation Phase of *Predator* ACTD	Eval integration of *Predator* system with CVBG operations • Real-time operations & intel support to CVBG missions: air strike, combat search & rescue, visit-board-search & seizure, non-combat evacuation, mobile missile targeting, and war-at-sea • Main UAV products: live video to carrier C2 nodes; imaging of mission areas & ops; BLOS transfer of UAV control; threat detection, tracking & cueing; target location, recognition & eval for air strikes; & long-range ship ID (in haze/night)	"'This first-ever integration of *Predator* UAV support for a (CVBG) was an unqualified success." Two *Predators* flew 83 hrs; lost 43 hrs for weather, maintenance, and flight operations restrictions Prior familiarization w/CVBG ops should be routine; range safety workarounds needed SATCOM time is expensive, could be limited; access could be critical to ops success Digital video signal preferable to the analog signals used UAV needs better connectivity to naval units; UAV would be enhanced with SAR, VHF/UHF radio, SIGINT, and laser rangefinder/target designator • *29 Dec 95 msg from Cmdr, Carrier Group 1, to CINCUSACOM (et al.)*
Predator-SSN Interoperability • Nuclear sub (SSN) control of *Predator* to support Navy SEAL team incursion • 30 May – 6 Jun 96 • Office of Naval Intelligence feasibility assessment of littoral missions for forward-deployed submarine (e.g., intel collection/surveillance, special forces operations, and strike)	Estab UAV-SSN link to demo SSN: • Control of UAV payload & AV • Receipt of UAV status info • Receipt, processing, display & recording of UAV imagery • Retransmission of UAV imagery using Joint Deployable Intel Support System (JDISS) UAV control system aboard SSN	UAV provided "a 15,000-ft-high periscope" for the SSN in: supporting initial surveillance, mission planning & SEAL team ingress; imaging target destruction & relaying imagery to JTF for real-time BDA; and monitoring SEAL team egress & recovery. Successful control transfer of UAV from/to its land base, & conduct of operations under at-sea/submerged conditions Small size of UAV-SSN interface system good for other ops – especially if: add SAR, second tracker display, more image processing; encrypt link; and improve target location accuracy • *Project and after-action reports*
Hunter ***Support for Joint Ops*** • 15th Mil Intel (MI) Bn support to 4th Inf Div ops at National Training Center (NTC), Ft Irwin, CA • 8 – 27 Jul 96 • *Hunter* support for ops concept refinement and continuation training (per USD(A&T) memo, 31 Jan 96)	*Hunter* support for 2nd Bde, 4th Inf: • Route recon and security, 24-hr coverage of battlefield; detected all live-fire tgts, enabled destruction of 42% of enemy *before* battle • Harmonized ftr-UAV ops: training, tactics, and procedures. Found and marked targets (tac recce); BDAs after notional strikes	UAVs gave "unprecedented view of the enemy" and credited with "major contribution to the fight" (informal report msg). Flew every mission (181.5 hrs), none lost to maintenance Improvements in managing fighters and UAV: *Hunter* flying a fixed altitude; fighters approach area high, then descend (in special area) below UAV for bomb runs Commander of 4th Inf Div "would like his division to train with UAVs as much as possible to further integrate the intel and targeting capabilities of the system...." *(reporting msg)*

Assuring a Developer-Warfighter Partnership



Valuable lessons learned, both from these demonstrations and exercises and from the operational deployments of *Predator* to Bosnia, have influenced flight and ground operational procedures, operator training, logistics concepts, and C4I interfaces. Direct dissemination of *Predator* video to a wide audience has also been a byproduct of these deployments as various command elements of the joint forces learned of this highly useful intelligence source.

Further, the *Predator*-COMPTUEX and -SSN demonstrations helped to explore maritime-unique as well as joint concepts. The Navy's three basic UAV marinization requirement levels are:

1. Shipboard receipt of UAV imagery;
2. Shipboard control of UAV and payload; and
3. Shipboard launch and recovery of the UAV.

The two demonstrations illustrated multiple opportunities for the first two levels, and contributed inputs to the Navy's recent *Predator* marinization study (see pages 5 and 43).

During FY 1996, most *Predator* assets have been committed to support Bosnia operations and the training base. For FY 1997, however, exercises such as the Army's Force XXI Warfighter Experiment and the joint exercise Roving Sands 97 plan to include *Predator.* These efforts will assist in the refinement of operational concepts and rigorously evaluate *Predator's* military utility against various battlefield situational awareness challenges. Over time, similar participation is anticipated from the HAE and TUAV ACTDs.

At the Fall 1996 Air Force Chief of Staff Corona Conference, a decision was made to establish a UAV Battle Lab at Eglin AFB, FL, to explore emerging areas of warfare for the next century. Details will be provided in next year's edition of this report.

UAV Roles in the Objective Architecture

Background

Concepts of Operations (CONOPS), based on demonstrated capabilities and emerging user needs, are being developed and refined. The tactical and endurance UAVs continue to project expanding technical and operational capabilities for increasing mission applications. In DARO's airborne reconnaissance Objective Architecture for 2010, UAVs will complement manned and space-based systems in their support of both combat operations and military operations other than war.

During the next few years, *Pioneer* and residual *Hunter* assets will be progressively replaced by *Outrider* systems for tactical mission support. In parallel, *Predator,* followed by a mix of *Global Hawk* and *DarkStar* systems, will be used to provide deep-look information for extended periods of time and varying conditions of risk. Thus, both tactical and endurance UAV systems will complement each other in performing a full range of surveillance and reconnaissance functions. They will help commanders at different echelons to (1) know what is on or approaching the battlefield before their forces get there, and (2) employ forces and weapon systems more efficiently as the result of precision targeting and BDA information.

UAV Operations in the Theater of the Future

A representative view of our UAVs' roles in a projected future contingency is shown on the next page. It depicts the key requirements, concepts and UAV capabilities discussed above, and shows how a mix of UAVs will support theater- and tactical-level operations. The illustration contains:

- A typical theater ground force (left), facing its area of influence across the forward line of own troops (FLOT) (to the right);
- Its echelons' areas of interest and nominal time-cycles (below), which illustrate each command level's operating context in terms of their differing range and time dynamics;
- UAVs depicted according to gradations of operating radius and area coverage capability, from *Outrider* (bottom left) to *Global Hawk* (top right), with their defining mission parameters (to the right of the operating area); and
- Generic communication links (LOS, and aircraft and satellite BLOS relays) that connect the UAVs with their joint force users, from ground force echelons to naval assets to close support and deep-strike tactical strike aircraft.

Key considerations (applying to the graphic overleaf) include the following:

1. Relative UAV area coverage and imaging capabilities vary considerably, according to system performance and payload, mission objectives, and primary user level.

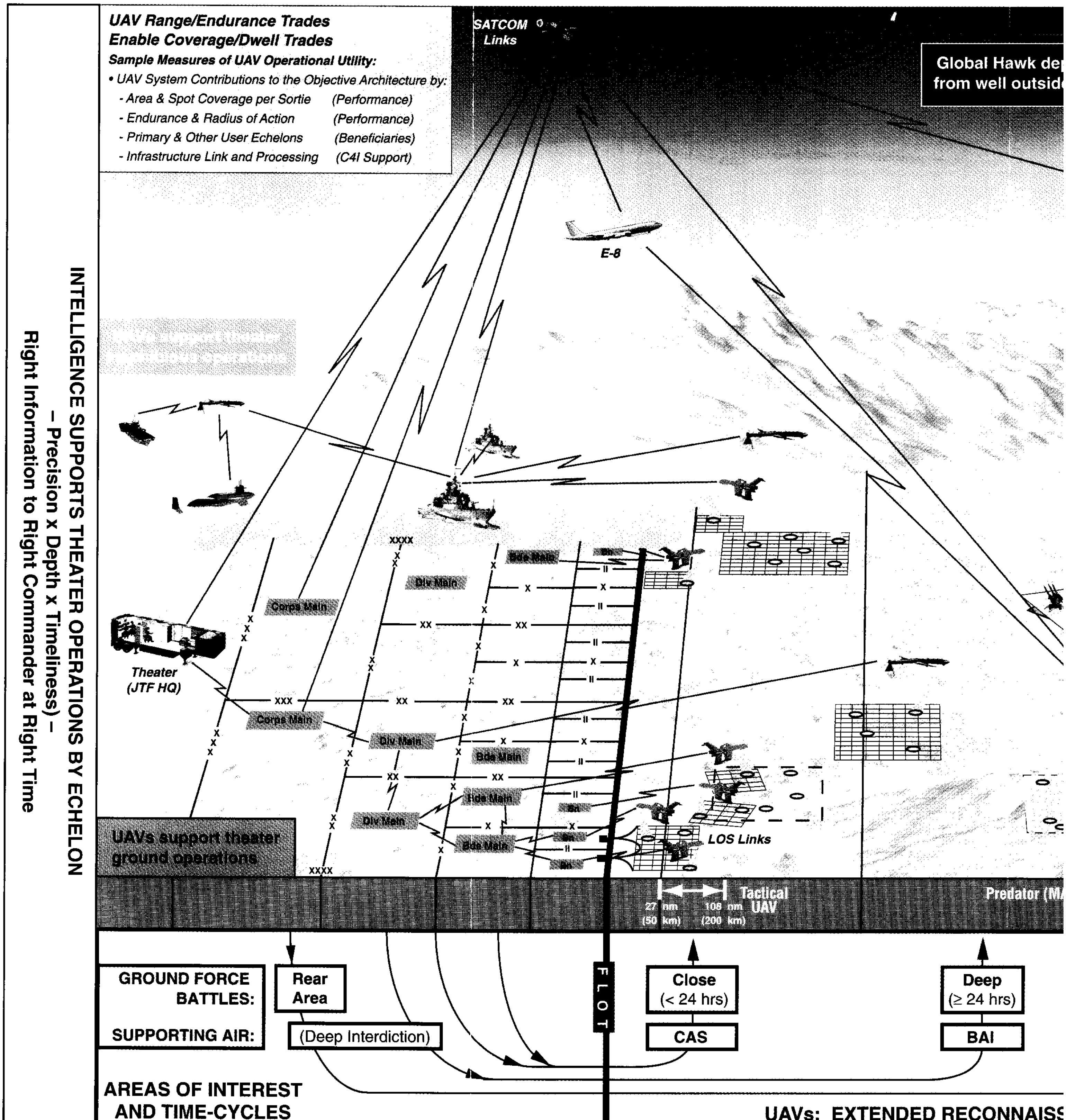
2. Different UAV capabilities respond to different user needs — in terms of quantity, quality and timeliness (QQT) of information needed to support each user's "battle." The main distinction is between target-spotting tactical UAVs and area-sweeping HAE UAVs, with *Predator* able to perform both functions to a degree.

3. UAV reconnaissance products require an advanced C4I infrastructure, comprising collection links (shown), and TCS, HAE CGS and imagery exploitation system (IES) processing facilities and dissemination links (not shown), to reach all users.

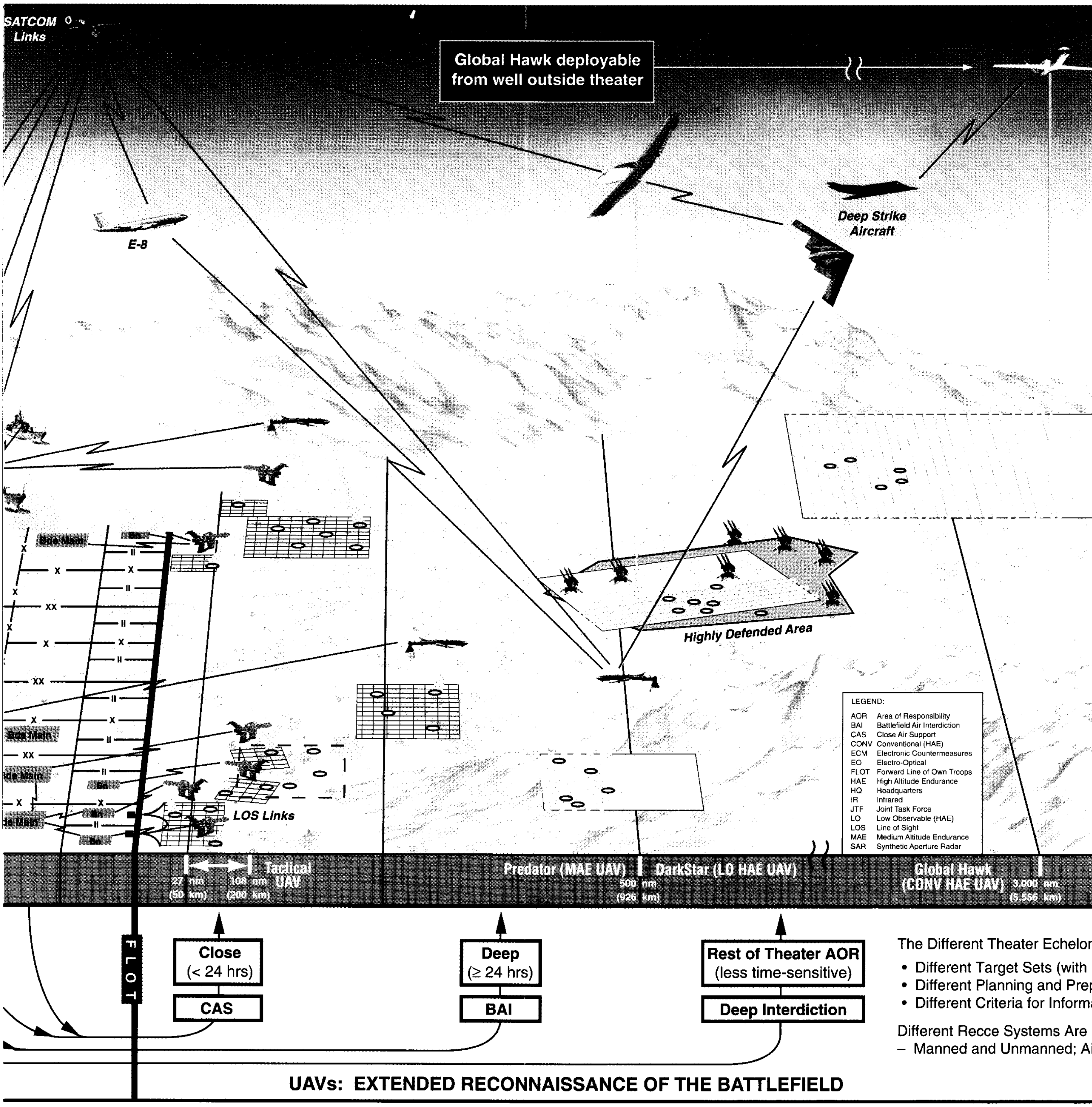
4. Two connectivity exceptions are (a) links to JSTARS (or other manned assets), and (b) the projected sensor-to-shooter link from endurance UAVs to strike aircraft, which symbolizes the goal of sending targeting data directly to weapon systems (on land and sea, as well as in the air) — thereby using reconnaissance as a means to achieve battlespace dominance.

5. Thus, this UAV "operational laydown" and different threats in a representative theater environment support the need for a UAV family of systems to meet expanding user requirements and to enhance joint force operations.

UAV Objective Operations in the



UAV Objective Operations in the Theater of the Future



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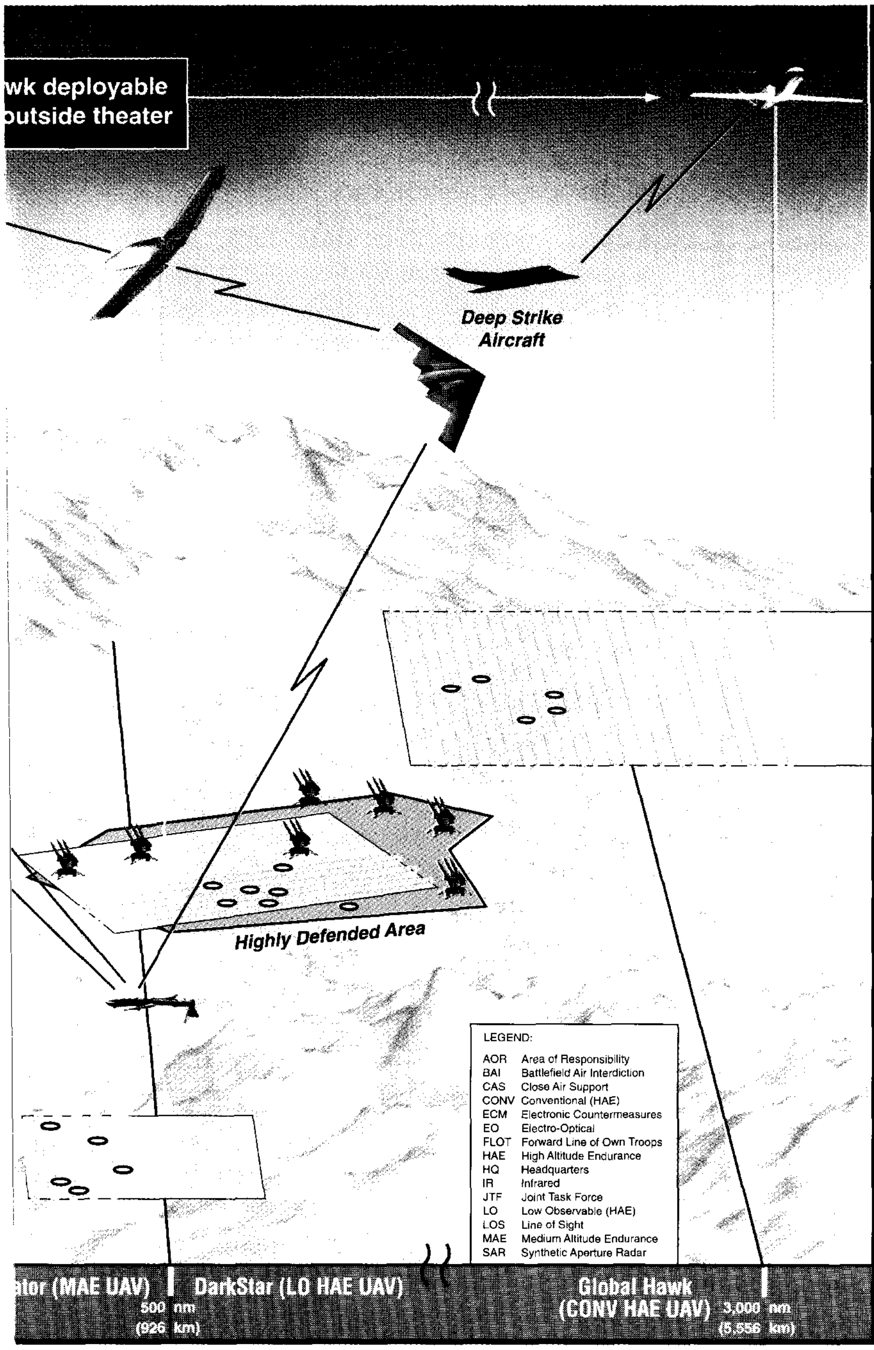
ı the Theater of the Future



KEY OPERATIONAL PARAMETERS

– ***Global Hawk*** **(CONV HAE):**
- Radius: 5,556 km (3,000 nm)
- Endurance: >40 hrs
- Broad Area Coverage: ≈140,000 km²/ day (40,000 nm²/ day)
- Spot Collection Mode: 1,900 frames / sortie
- Sensors: EO, IR, and SAR
- Self-Defense Measures: Threat Warning, ECM, Decoys

– ***DarkStar*** **(LO HAE UAV):**
- Radius: >926 km (>500 nm)
- Endurance: >8 hrs
- Broad Area Coverage: ≤48,000 km²/ sortie (≤14,000 nm²/ sortie)
- Spot Area Coverage: ≤620 frames / sortie
- Sensors: EO or SAR
- Survivability Measure: Very Low Observability

– ***Predator*** **(MAE UAV):**
- Radius: 926 km (500 nm)
- Endurance: >20 hrs
- Maneuver Area: ≤41,000 km²/ day (≤12,000 nm²/ day)
- Sensors: EO, IR, and SAR

– ***Outrider*** **(TUAV):**
- Radius: >200 km (>108 nm)
- Endurance: >4 hrs
- Maneuver Area: >3,100 km²/ sortie (>900 nm²/ sortie)
- Sensors: EO and IR

UAV UTILITY

OPERATIONAL INTEL COLLECTION:
Broad Area Coverage and Spot Target Potential

TACTICAL INTEL COLLECTION:
Area Search and Target Track Potential (w/in Echelon's Area of Interest)

VARIED NEEDS Require a Family of UAVs

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Rest of Theater AOR
(less time-sensitive)

Deep Interdiction

The Different Theater Echelons Fight Different "Battles" with:
- Different Target Sets (with Different Operating Cycles)
- Different Planning and Preparation Time Factors
- Different Criteria for Information Precision and Timeliness

Different Recce Systems Are Needed to Meet Those Criteria
– Manned and Unmanned; Airborne, Surface and Space

ıAISSANCE OF THE BATTLEFIELD

Technologies and Applications

On 16 January 1996, USD(A&T) Dr. Kaminski first discussed ten primary "enabling technologies and architectural concepts that are needed to build dominant battlefield cycle times...." All are relevant to airborne reconnaissance.

Key Enabling Technologies	
1. Advanced Processing	2. Automatic Target Processing (ATP)
3. A Common Grid	4. Distributed and Open Architectures
5. Sequential Application of Off-Board Collectors	6. Data Compression
7. Very Large, Dynamic, Object-Oriented Data Bases	8. Data Storage
9. Data Dissemination	10. Planning Analysis Tools

Background

Over the past year, DARO has focused its technology budget on those technologies that best support the realization of the airborne reconnaissance Objective Architecture for 2010. The Advanced Technology budget includes investments in maturing, high-payoff technologies that facilitate the timely attainment of the Objective Architecture. Other technologies sponsored by Government and industry are also monitored and funded pending their availability for direct application to reconnaissance platforms and ground stations.

The nine technology transition programs comprising DARO's Advanced Technology plan for FY 1996 (as defined in the Airborne Reconnaissance Technology Program Plan of December 1994) have evolved into ten technology transition focus areas for FY 1997, with additional initiatives supported by the Congress. The transition areas, all of which impact UAVs, are described below.

Airborne Reconnaissance Technology Transition Areas

FY96	FY97	*Remarks*
Low-Cost Reconnaissance Pod	Reconfigurable Pods	*Near-term focus on manned recce; UAV applicat'ns later*
Integrated Avionics	Integrated Avionics	*(See MIAG discussion on page 41)*
Exigent Target Detection	Exigent Tgt Detection	*E.g., MSI, HSI, and FOPEN SAR*
Precision Geolocation	Precision Geolocation	*SIGINT & imagery all-wx precision targeting & mapping*
SIGINT Technology	SIGINT Upgrades	*Modular, incremental JSAF approach*
Imagery Screening & Analyst Cueing	Screening & Cueing	*Reducing wide-area search time for critical targets*
Auto Target Recognition (ATR) & Correlation	ATR & Correlation	*Algorithm development & data correlation*
Common Data Link (CDL) Advanced Technology	CDL Advanced Tech	*Enabler of UAV interoperability*
High-Data-Rate (HDR) Uplinks & Crosslinks	HDR Links	*EHF/Laser alternatives under study*
	Fusion	*Goal of multi-sensor fusion to locate hidden targets*
Congressional Technology Initiatives (added)	Cong'l Tech Initiatives	*EO Framing Sensor; Multifunction Self-Aligned Gate*

EHF	Extra High Frequency	FOPEN	Foliage-penetration (radar)	HSI	Hyperspectral Imagery
JSAF	Joint SIGINT Avionics Family	MIAG	Modular Integrated Avionics Group	MSI	Multispectral Imagery

During the Advanced Technology programming process, DARO carefully considers applications and priorities in terms of their ultimate utility to the warfighter. This criterion is applied within each of the four technology categories defined for airborne reconnaissance: platforms, sensors, information processing, and communications. As an example, the sensing/exploitation roadmap on the next page shows how specific sensor and processing technologies are being developed to meet evolving mission needs.

Sensing/Exploitation Roadmap

Term	Technologies	Capabilities
Near Term: 0 – 5 yrs Integrate state-of-the-art	• Synergistic SAR/moving target classification • High-resolution MTI, SAR, Inverse SAR • Interactive target recognition • Digital recce implementation • Real-time video exploitation	Find isolated targets and military formations operating in simple scenes: – Targets moving or stationary – Limited number of target models Stylized force structures
Mid Term: 5 – 10 yrs Increase target features	• Polarimetric SAR • Coherent change detection • VHF/UHF SAR/MTI and ATR • Multi-/hyperspectral imagery and ATR • Ultra-high-resolution SAR • Sensor fusion	Find targets in more difficult scenes: – Targets in tree lines or partially obscured by foliage and camouflage – Medium number of targets; rapid target insertion Adaptable to force structures
Far Term: 10 – 20 yrs Increase tgt exposure & features	• Numerous sensor platforms • Dialable sensor disciplines • Agile beam SAR • 3-D SAR and ATR • Integrated system	Find reduced-signature targets in complex scenes -- With intense camouflage, concealment and deception (CC&D) or in foliage -- Large number of targets Diverse mix of platforms and sensors

Micro-UAVs

In addition to rationalizing, focusing and prioritizing relatively mature technologies, DARO also supports more revolutionary initiatives — especially where they show promise of meeting needs that could not otherwise be satisfied by incremental developments.

One example is a new DARPA initiative to develop a micro-UAV. This class is defined as a UAV measuring less than 15 cm (≈ 6 inches) in any dimension, yet carrying a miniaturized payload, simple avionics and a communication link sufficient to perform needed missions. Following an MIT Lincoln Laboratory proposal, a November 1995 DARPA workshop explored concepts and technologies to accelerate the development of this UAV type. Many challenges were identified for such small UAVs, from their physics of flight to integration of even simplified functions — developing an "airplane on a chip"; however, their six-degree-of-freedom flexibility offers high military potential in constrained operating environments, such as within urban areas or supporting small unit operations. DARPA's project will focus on:

- Critical flight-enabling technologies (e.g., aerodynamics, flight control, navigation, and propulsion);
- Integration strategies that maximize range-payload performance and mission utility; and
- Near-term operational concepts, with an emphasis on those that lend themselves to early operational demonstration.

Current Technology Applications

Many more technology initiatives are being pursued via DARO sponsorship or support. The facing table lists relatively mature technologies that will be leveraged across airborne reconnaissance systems. Some may be incorporated into current DARP UAV program baselines (following their transition from ACTD to acquisition status); others may be incorporated within later P3I efforts. Several of these technologies offer potential for new surveillance and reconnaissance missions with relatively small investment. Several also meet emerging requirements for special functions and military operational conditions other than war, thereby providing our forces with contingency capabilities as the new century approaches.

Current UAV Technology Applications
Heavy Fuel Engine (HFE) • Objective: Provide UAVs with a safe, readily available fuel source for DoD system commonality • Status: In FY96, the UAV JPO released a Request for Information to industry for engines applicable to *Outrider* and *Predator.* A Request for Proposal to pursue this technology may follow in early FY97
Communications Relay Payload (CRP) • Objective: Routinely use UAVs for airborne relay to free manned aircraft for other missions • Status: A CRP has been integrated into a *Hunter* and was successfully demonstrated in April 1996
Joint SIGINT Avionics Family (JSAF) • Objective: Open systems architecture suite of SIGINT sensor equipment with standardized interfaces and multi-platform applicability (based on Joint Airborne SIGINT Architecture [JASA]) • Status: Prototype systems under development; plans made for a moderately paced acquisition
Laser Designator/Rangefinder (LDRF) Payload • Objective: Accurate targeting for precision guided munitions without risk to aircraft or ground spotters • Status: An off-the-shelf payload was integrated into a *Hunter* and successfully demonstrated in FY96. An effort is in planning to demonstrate an LDRF application for *Outrider*
Mine Countermeasures Payload • Objective: UAV-borne mine detection capability to avoid risk to ground troops and naval forces • Status: The Coastal Battlefield Reconnaissance and Analysis (COBRA) payload has been integrated into a *Pioneer* for flight test in early FY97
Common Data Link (CDL) • Objective: Interoperability of data links and data exchange among sensors, platforms, and their users • Status: An upgraded light-weight, low-power digital data link, interoperable with CDL, is planned for development and integration on *Outrider*
Hyperspectral Imaging (HSI) • Objective: Improved detection of hidden or camouflaged objects by spectral discrimination • Status: Hyperspectral sensors for *Pioneer* and *Predator* tested and real-time tactical cueing of onboard cameras demonstrated. *Predator* HSI will be integrated with the CC&D ACTD in FY 1998
Downsized Synthetic Aperture Radar (SAR) • Objective: Smaller, lighter, cheaper SAR sensors to increase UAV payload and performance • Status: In addition to DARPA's Low Cost Radar components development program, DARO and the UAV JPO are co-chairing an IPT to plan the development of an adverse-weather imagery payload for *Outrider*
Wideband SAR (Foliage Penetrating [FOPEN] Radar) • Objective: Improve all-weather detection of targets concealed by foliage or camouflage • Status: FOPEN SAR scheduled for integration on *Predator;* integration on other UAVs via the Counter CC&D ACTD in FY 2000
Focal Plane Arrays (FPAs) • Objective: Develop large-format FPAs for improved imaging compared to film or line scanning sensors • Status: 25-Megapixel FPAs demonstrated; under consideration as *DarkStar* EO sensor upgrade
Video Imagery (per DSB Task Force on Improved Applications of Intelligence to the Battlefield, Jul 96) • Objective: Improve video image quality, and provide cataloguing, retrieval and exploitation capabilities • Status: Studies on improvement of *Predator* imagery quality and imagery archival
Global Positioning System (GPS) Pseudolites • Objective: Enhance warfighter resistance to GPS jamming by rebroadcasting GPS data from UAVs • Status: Planning and concept development underway for pseudolites on UAVs
Automatic Target Recognition (ATR) • Objective: Improve target discrimination in wide-area imagery, and minimize data link bandwidth • Status: Demo of multi-platform moving target imaging and ATR exploitation scheduled for 1998 on an endurance UAV. On-board ATR to reduce data link loading under development

Payload and Modification Programs

Payloads

Last year's UAV report summarized a variety of payload and related technology demonstrations and experiments. This year, work has continued in specific areas with renewed top-level planning in light of the recent changes in UAV acquisition. Payload activities include:

- Specific payload demonstration projects managed or supported by the UAV JPO (some of which were in the "Technology" section last year); and
- A payload prioritization process, under the aegis of the JROC's UAV Special Study Group (SSG), with inputs from the CINCs and supported by DARO.

UAV JPO Payload Projects

The UAV JPO conducts proof-of-principle demonstrations of mature UAV sensor payloads to evaluate their suitability for tactical UAV applications. This activity provides a systematic approach to the integration of common growth mission payloads across the UAV family. During the FY 1995 – FY 1996 time frame, fourteen payloads have been demonstrated aboard *Pioneer* and *Hunter,* as representative UAV testbeds — lighter payloads aboard *Pioneer,* and heavier payloads aboard *Hunter.* Most of the demo reports were issued during FY 1996; the rest will be completed early in FY 1997. Additional payload demonstrations are planned for *Predator,* starting in FY 1996/97. All results are inputs to the JROC SSG's payload prioritization process.

Demonstration Payload	Potential Mission Application	Platform	Report
Meteorological Sensor	- Systematic atmospheric readings	Pioneer	Nov 95
Radiac Sensor	- Plot suspected NBC contamination	Pioneer	Nov 95
Lightweight Standoff Chemical Detector	- Detect and plot toxic agents	Pioneer	Nov 95
Lightweight Comms Intelligence (COMINT) Payload	- Find/ID ground comms emitters	Pioneer	Nov 95
Surface Acoustic Wave (SAW) Chemical Detector	- Detect/plot low-level chem agents	Pioneer	Nov 95
Hyperspectral Sensor (HSS)	- Detect hidden/difficult targets	Pioneer	Aug 96
Coastal Battlefield Recon and Analysis (COBRA) [1]	- Detect mines (day/limited visibility)	Pioneer	Nov 96
Tactical Remote Sensor System (TRSS) [1]	- BLOS ground sensor data relay	Pioneer	Nov 96
Communications Relay	- BLOS comms relay for gnd forces	Hunter	Aug 96
Laser Designator/Rangefinder (LDRF)	- Demo LDRF for *Hunter's* payload	Hunter	Oct 96
Electronic Intelligence (ELINT) Payload[2]	- Locate/ID enemy ground radars	Hunter	Nov 96
Radar Jammer Payload[2]	- Jam enemy ground radars	Hunter	Nov 96
Lighter-Weight COMINT Payload[2]	- Find/ID ground comms emitters	Hunter	Nov 96
Communications Jammer Payload[2]	- Jam both radios and data links	Hunter	Nov 96
HSS/FOPEN Radar/Air Traffic Control Compliance System (ATCCS) [3]	- Demo for SOUTHCOM and Central MASINT Office (CMO)	Predator	(TBD)
Tactical Meterological (Dropsonde) System (TMS) (mounted in a conformal pod)[4]	- Demo of near-real-time weather data from remote/denied areas	Predator	(TBD)

ID Identify MASINT Measurements and Signatures Intelligence NBC Nuclear, Biological, Chemical

1 Joint UAV JPO-Marine Corps Systems Command project.
2 Joint UAV JPO-Joint Command and Control Warfare Center (JC2WC) project.
3 Supported by UAV JPO's MAE UAV Project Team and the National Reconnaissance Office (NRO).
4 Supported by UAV JPO's MAE UAV Project Team and the Naval Research Laboratory's Tactical Oceanographic Warfare Support (NRL/TOWS) Program Office.

Specific FY 1996 accomplishments include:

- Hyperspectral Imaging *(Pioneer)*: HSS detection of hidden targets showed the feasibility of location and tracking missions against non-visible targets and activities.
- Comm/Data Relay *(Hunter)*: VHF and UHF half-duplex voice and data relays to a range of 120 km showed the feasibility of longer UAV ranges while maintaining a BLOS link.
- Laser Designator/Rangefinder *(Hunter)*: Four successful ground launches of Hellfire missiles against *Hunter*/LDRF-designated targets demonstrated the feasibility of precision targeting by UAVs.

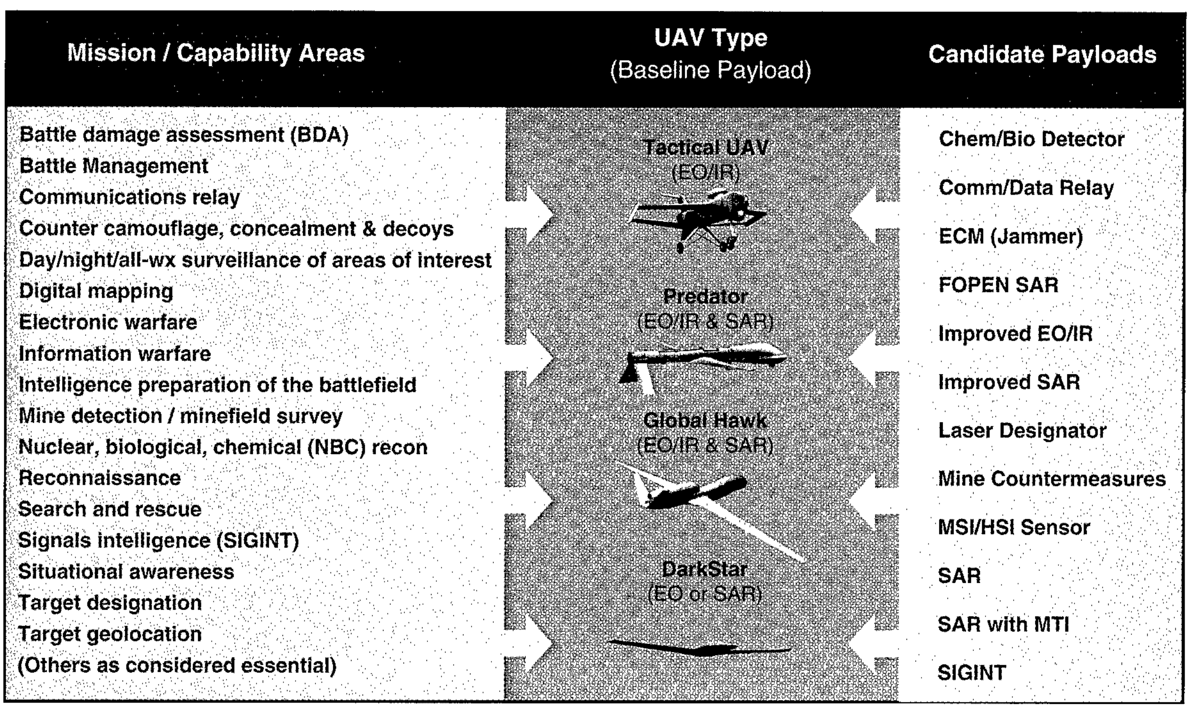
Additional payload projects include demonstrations of: a UAV electronic decoy to support tacair strike forces; all-weather imaging of moving ground targets using an Army moving target indicator (MTI) radar; and the Airborne Standoff Minefield Detection System (ASTAMIDS) as key to future Army mine countermeasures.

JROC Special Study Group Activities

The JROC's UAV SSG resumed its follow-on payload prioritization work in the Spring of 1996. Following a DARO payload briefing, the SSG asked the CINCs and Services to submit priorities for 17 mission areas and capabilities for the four primary UAV types *(Global Hawk, DarkStar, Predator,* and Tactical UAV). With these inputs and parallel payload inputs by DARPA, the UAV JPO and DARO, the SSG is currently developing a prioritized payloads list by UAV. (A representative matrix is shown below.)

Results will first be presented to the JROC for approval and then forwarded to the USD(A&T) in early FY 1997.

JROC UAV SSG's Payload Prioritization Process



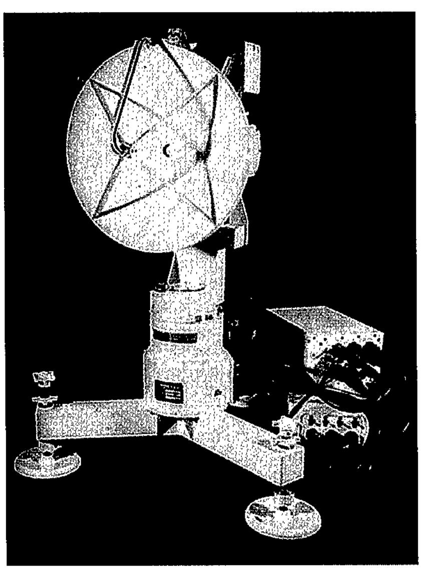
Current Technology Applications

Each of the four primary UAVs anticipates a vigorous preplanned product improvement (P3I) program, as their ACTDs help to identify needed features, which are then (1) mapped against existing requirements and emerging needs, and (2) matched to technology maturity, feasible schedules, and available funds. The main current activities are:

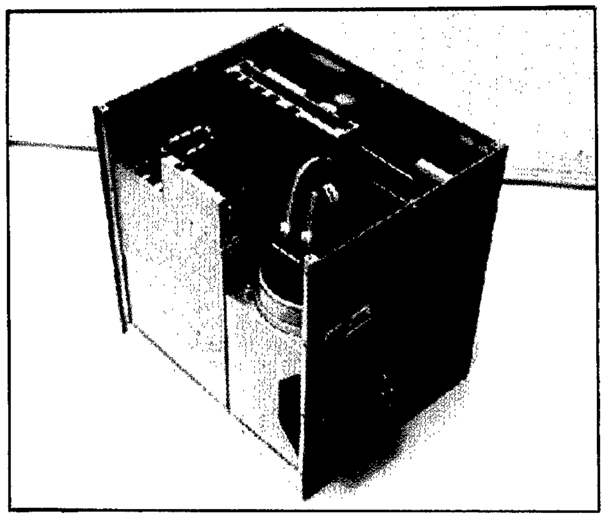
- Incorporation of a UAV Common Automatic Recovery System (U-CARS) and improved avionics (via the Modular Integrated Avionics Group [MIAG] program) — both potentially for all tactical UAVs; and
- Definition of the LRIP configuration and P3I program for *Predator,* as part of its transition from ACTD to full acquisition program.

Predator's P3I program was addressed on page 19; U-CARS and MIAG updates are presented here. Both of these programs are managed by the UAV JPO.

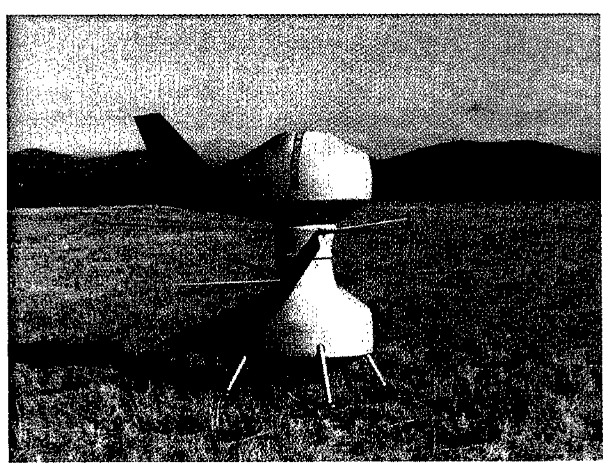
U-CARS. The purpose of this program is to provide system positioning data that will enable automatic land or shipboard recovery of UAVs, thereby reducing operator training needs and fatigue, the risk of mishaps, and associated costs. Initially supported by Congress for *Pioneer,* U-CARS is being tested for land-based operation in 4Q FY 1996 and sea-based operation in 1Q FY 1997. Plans also include integration into both *Predator* and *Outrider:* a *Predator* integration study is currently underway, and integration into *Outrider* is an option on its current ACTD contract.



MIAG. This program's objective is to improve UAV flight performance via a common, modular, smaller and lighter vehicle/flight management system. Functions include: AV subsystem monitoring and control, flight control, navigation, guidance, and payload control. Engineering development models will be flight-tested aboard *Pioneer* in early FY 1997, with production of 66 MIAGs planned to start thereafter; an IFF module is also undergoing development for later procurement. In addition, MIAG may be incorporated into *Predator, Outrider,* and target drones.



VTOL Evaluation. For FY 1997, the Congress provided $15 million for the flight testing of the Puma VTOL tactical UAV, which was one of the candidates in the TUAV ACTD competition. Planning for this evaluation will begin shortly.



Issues and Challenges

Our principal challenge is to efficiently acquire UAV systems that support valid warfighter requirements and are consistent with Joint Vision 2010 in providing dominant battlespace awareness. We focus our efforts in four areas: acquisition, technology initiatives, architecture, and operations.

Acquisition

UAV systems must be compatible with JROC-validated requirements. Fiscal plans must support a balanced approach to the current JROC priorities for UAVs: Tactical UAV *(Outrider* and *Pioneer),* MAE UAV *(Predator),* and HAE UAVs (*Global Hawk* and *DarkStar*). In a resource-constrained environment, DARO is challenged to provide adequate funding to sustain existing UAV systems (e.g., *Pioneer* until *Outrider* is evaluated, acquired, and fielded). In addition, for all our ACTDs we must plan for transition to production, logistics support and training, and test and evaluation. We will implement acquisition streamlining principles using cost as an independent variable (CAIV) and capitalizing on commercial off-the-shelf technology and opportunities.

Our major acquisition issues are summarized in the table below.

UAV Issue	Issue Aspects	Major Considerations
Predator **Production and Cost**	• Enhanced configuration vs. force size objective vs. budget constraints	• A baseline configuration plus P3I program to meet user needs • Initial limitation of force size/production rate to meet funding • System production cost reflects incorporation of all the 'Ilities (vs. ACTD demo system's "flyaway" cost). — *Not* "cost growth"
Outrider **ACTD**	• Application of lessons learned from the *Hunter* program and *Predator* ACTD	• ACTD structured to reflect those lessons-learned, to include: – Adopting the ACTD approach to resolve requirements and utility issues early and with streamlined pgm management – User involvement through IPTs – Controlling costs from the start, to assure affordability
Outrider **LRIP**	• Exercise of LRIP option prior to ACTD results	• Provides an orderly and formal process for timely ACTD transition to a DoD production program to procure and field systems
Tactical UAV Availability	• #1 priority for ground forces, but still unmet • Limited assets cannot meet multiple needs	• Tactical UAV ACTD structured for flexibility, hence success; meanwhile — • *Pioneer* programmed for extension of operational life • Current/near-term *Predator* assets can meet some needs
HAE UAVs	• Demo of military utility • Force size and mix • Capabilities vs. cost	• Flight test & demo pgms realigned (for *DarkStar's* return to flight) • Ultimate *Global Hawk-DarkStar* mix subject to demo & eval • Added capabilities and cost impacts under study; P3I possible
UAV Interface w/C4I Infra-structure	• Need end-to-end UAV system operation • Systems to function in evolving architectures • Emphasis on timely use of UAV *products*	• Common TCS and interoperable HAE CGS to assure UAV cross-use. Resolving TCS program/budget issues is a high priority • Standard interfaces and high-data-rate robust links to assure connectivity & interoperability across the operating environment – Per guidance by the Joint Technical Architecture (JTA) and DARO's Airborne Reconnaissance Information Technical Architecture (ARITA)

Technology Initiatives

This year, we focused on critical technology and high-payoff industry R&D initiatives, coupled with off-the-shelf software and hardware to leverage UAV capabilities. We identified near-term fixes that are compatible with the CINCs' annual Integrated Priority Lists and validated by the Chairman's Program Assessment for the Intelligence, Surveillance and Reconnaissance (ISR) functional area to meet UAV requirements. Initiatives include the Tactical Common Data Link (TCDL) and enhanced sensor capabilities.

The TCDL) provides a family of CDL-compatible, lower-cost, lightweight digital data links with variable data rates. This effort will support both manned and unmanned programs (including *Pioneer, Predator,* and *Outrider),* and will emphasize an open architecture with CDL interoperability at the 10.71 Mbps (downlink) and 200 kbps (uplink) rates.

Enhanced sensor capabilities proceed with critical payload technologies (subject to the ongoing JROC payload prioritization process), and provide for adverse weather sensing capabilities (such as a lightweight tactical SAR) and other promising technologies (like longwave infrared sensing, FOPEN radar, and HSI).

Architecture

Dr. Kaminski's "ten enabling technologies and architectural concepts" are listed on page 37. DARO will continue to exploit distributed, open architectures that use CIGSS for imagery-based platforms and JASA for SIGINT applications. This approach will provide cost savings, emphasize the application of best commercial practices, and support adaptability through an open, flexible, digital family of processors, software, and operating systems. In addition, DARO is developing the TCS architecture to ensure interoperability between different UAVs and ground stations to share sensor data, control the sensors themselves, and (when appropriate) control the UAV platforms.

Operations

UAV ACTDs, such as *Predator's,* have already markedly improved the way operational forces can receive intelligence support and view the battlefield. Ground commanders want responsive collection systems that provide critical information to enhance battlefield situational awareness, and developmental UAV systems must support user-validated CONOPS. Here, four UAV subareas are noteworthy: multiple-UAV operations, airspace management, marinization, and imagery archival/retrieval. They are summarized below.

Multiple-UAV Operations	We are just beginning to understand the operational impact of multiple-UAV operations. Issues such as air traffic separation, weapons deconfliction, sensor priorities and battle management integration must be resolved
Airspace Management	We are continuing both national and international coordination to permit UAVs to share airspace with manned platforms (see page 27). We are resolving near-term airspace issues through field activities, and working with FAA headquarters to understand the new procedures and capabilities needed for more general unmanned flight. FAA involvement and acceptance are essential to the coordination of UAV flight and control procedures for all types of air operation
UAV Marinization	In consonance with JROC priorities for Navy and Marine Corps requirements, marinization seeks to provide UAV support for deep-water, littoral and amphibious operations, through either the flexible TCS for control of UAV imagery products and sensors, modification of UAV platforms to operate from large air-capable ships, or both. A preliminary feasibility study on marinizing *Predator* will be published in early 1997 (see page 5)
Imagery Archival/ Retrieval	Data management systems need to leverage all commercial developments. We will need very large, dynamic, object-oriented databases that will allow us to store and transport imagery to support the warfighter wherever deployed

Management Approach

DARO builds solutions to the above issues through policy, management and programmatic oversight of DARP acquisition programs. In addition, we provide the warfighter with ready access to technology breakthroughs, set standards for interoperability and commonality, and are establishing a migration path to achieve the airborne reconnaissance Objective Architecture by 2010. In these functions, we are guided by the DARSC (see page 11) and the JROC's ISR JWCA (see page 6).

Resolution of issues presents a significant challenge to our vision, our processes, and our resources. To meet the challenge, DARO has undertaken two major initiatives:

- Formation of the new DARO Architecture Development (DAD) Team, which will definitize a candidate Objective Architecture and plan investment strategies; and
- Participation in the JROC's recent Reconnaissance Study Group (RSG) to perform cost/benefit analyses to identify optimal force packages for varying funding levels.

Both activities consider information needs, integrate military worth into force mix decisions, and identify optimal investment strategies given future resource constraints.

Plans and Projections

UAVs and Joint Vision 2010

UAV systems will contribute to the capabilities envisioned in JV 2010, and may be used to support all four of its operational concepts. By the time JV 2010 is implemented in FY 1998, *Predator* will be in production and the other UAVs will be demonstrating their capabilities in representative operational environments for joint warfighters.

UAV Type	*JV 2010* Concept	UAV Contributions
Tactical:	• Dominant Maneuver	– All-weather, accurate and timely RSTA imagery for tactical units
	• Precision Engagement	– Shorter-range target ID, geolocation and cueing, plus BDA
	• Full-Dimension Protection	– Direct support to tactical echelons with reduced risk to personnel
	• Focused Logistics	– Simplified support via HFE, sensor commonality, standard links
Endurance:	• Dominant Maneuver	– All-weather RSTA imagery at long ranges to meet theater needs
	• Precision Engagement	– Longer-range target ID, geolocation and cueing, plus BDA
	• Full-Dimension Protection	– Wide-area/long-dwell/stealthy increase situational awareness
	• Focused Logistics	– Simplified support via sensor commonality, info and link standards

Specific UAV program decisions planned to occur by the year 2000 include:

- Extension of *Pioneer's* phasedown;
- *Predator* production and support programming;
- *Global Hawk* and *DarkStar* force mix, production and configuration/P3I, with HAE CGS production determined by the UAV production decision;
- *Outrider* conversion from an ACTD to an acquisition program; and
- Priority development of TCS, to assure interoperability of tactical UAVs and connectivity with the HAE UAVs.

In parallel with these platform/facility decisions, (1) series of payload and technology application decisions will be made to expand and improve the mission capabilities of their host systems, and (2) architecture and infrastructure technical interface standards will be inherent in (or incorporated into) their interfacing links and information processing and exploitation functions.

Specific UAV payload developments planned by the year 2000 include: MTI, SAR, HSI, and NBC detection and meteorological sensors; a communications data relay; an electronic warfare decoy; a laser designator/rangefinder; and SIGINT. Other P3I will include the integration of U-CARS and MIAG equipments. Additional payload applications to the HAE UAVs will be studied as their ACTD matures. Maturing technologies will also emerge as new demonstration programs.

Specific C4I interface and infrastructure decisions planned by the year 2000 will involve the integration of:

- CIGSS standards for imagery; and
- JSAF standards and/or modules for SIGINT applications.

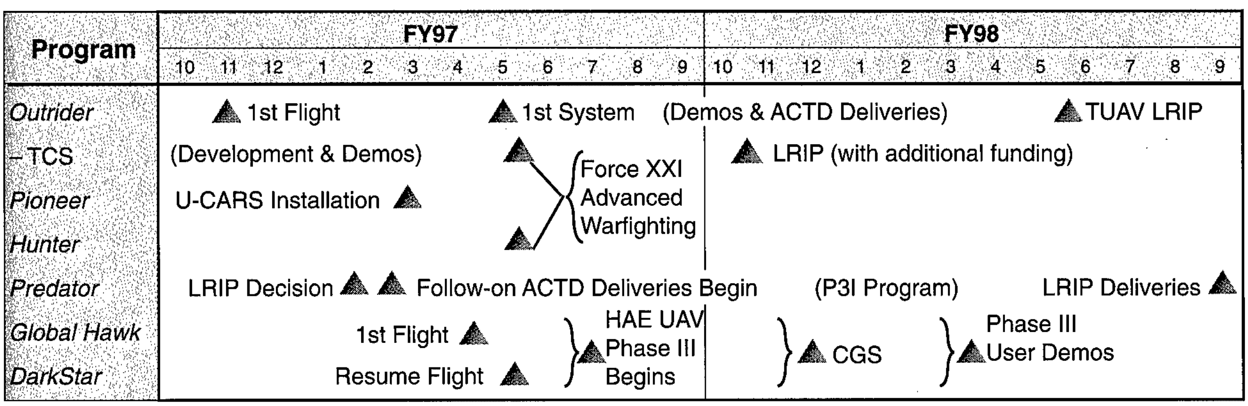
In this manner, UAV systems will complement manned systems in the airborne reconnaissance Objective Architecture and, at the same time, conform to the emerging Joint Technical Architecture and the concepts of JV 2010. The actual pacing functions for these interrelated program events will depend on:

- The relative success demonstrated by the UAVs and their related infrastructure and subsystems;
- The support they receive from the JROC (representing warfighters and other users) via the JWCA and JV 2010 implementation processes; and
- Stable funding levels over the next decade.

Director's Forecast

Near Term	Longer Term

During the next year I expect to see:
• Outrider's *first flight (November 1996)*
• *Completion of* Predator's *Marinization Study*
• *Continued* Predator *support in Bosnia*
• Global Hawk's *first flight (3Q/FY 1997)*
• *U-CARS integration on* Pioneer
• *Focus on* Predator's *transition to production:*
  – *P3I program defined; and*
  – *Initiation of LRIP program*
• *Programming for the Tactical Control System*
• *Additional de-icing capability on* Predator
• *The first* Outrider *system delivered*
• DarkStar's *return to flight*
• *A Force XXI advanced warfighting experiment to explore and validate new uses of UAVs in operational scenarios*
• *Continuing growth payload demos on UAVs*
• *Submission to Congress of a funding and testing profile for Puma*
	Our longer-term plans include:
	• *Prioritization and programming of payloads*
	• *Continuation of* Predator *P3I upgrades*
	• *Demonstration of military utility of the HAE UAVs,* Global Hawk *and* DarkStar, *in a series of exercises*
	• *Demonstration of military utility on land and sea for* Outrider
	• *Funding to sustain* Pioneer *through FY 2003*
	• *Focus on transition to production for* Outrider, *and fielding to tactical units*
	• *Preparations for HAE UAV production decisions*
	• *A focus on migration steps toward the DARO's Objective Architecture, and key roles to be played by UAVs*
	• *Fielding of lightweight, tactical, low-cost SAR and accompanying digital data link*



Conclusion

This past year we have made great strides toward developing a family of tactical and endurance UAVs that will meet new warfighting requirements. Contingency deployments as well as CONUS demonstrations continue to reveal new ways UAVs can be used to meet the needs of joint warfighters. Our acquisition reform and integrated architecture efforts are receiving widespread support both within the DoD and from the Congress as we seek to attain a balanced unmanned/manned/space-based surveillance and reconnaissance capability. As UAVs prove their military utility and affordability, they will increasingly become an integral part of our nation's reconnaissance force.

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